

IZe3Ic
1940

UNIVERSITY OF ILLINOIS

COLLEGE OF ENGINEERING

UNIVERSITY OF ILLINOIS BULLETIN

THE MAIN CAMPUS of the University of Illinois is situated partly in the city of Urbana and partly in the city of Champaign, in Champaign County, about fifty miles northeast of the geographical center of the state. The two municipalities form one community of about thirty-four thousand inhabitants.

The College of Medicine, the College of Dentistry, and the College of Pharmacy are located in Chicago, near the Cook County Hospital.

The land occupied by the University includes the main campus, 414.5 acres; the Chicago campus, 3.2 acres; the experiment farms at Urbana-Champaign, 1,146.25 acres; experiment fields outside Champaign County, 605.1 acres; and timber reservations, 60 acres; —a total of 2,229.05 acres. There are about 65 buildings on the main campus and 27 buildings on the experiment farms at Urbana-Champaign. (See map inside back cover.)

The total enrollment of students in the first semester of 1939-1940 was 12,290, excluding students registered for correspondence courses only. There were 11,070 resident students in the Urbana departments, and 1,220 in the Chicago departments. In addition there were 384 extramural students. The enrollment in the College of Engineering was 1,809.

UNIVERSITY OF ILLINOIS BULLETIN

VOL. XXXVIII

OCTOBER 29, 1940

No. 10

Published weekly by The University of Illinois. Entered as second-class matter December 11, 1912, at the post office at Urbana, Illinois, under the Act of August 24, 1912. Acceptance for mailing at the special rate of postage provided for in section 1103, Act of October 3, 1917, authorized July 31, 1918.

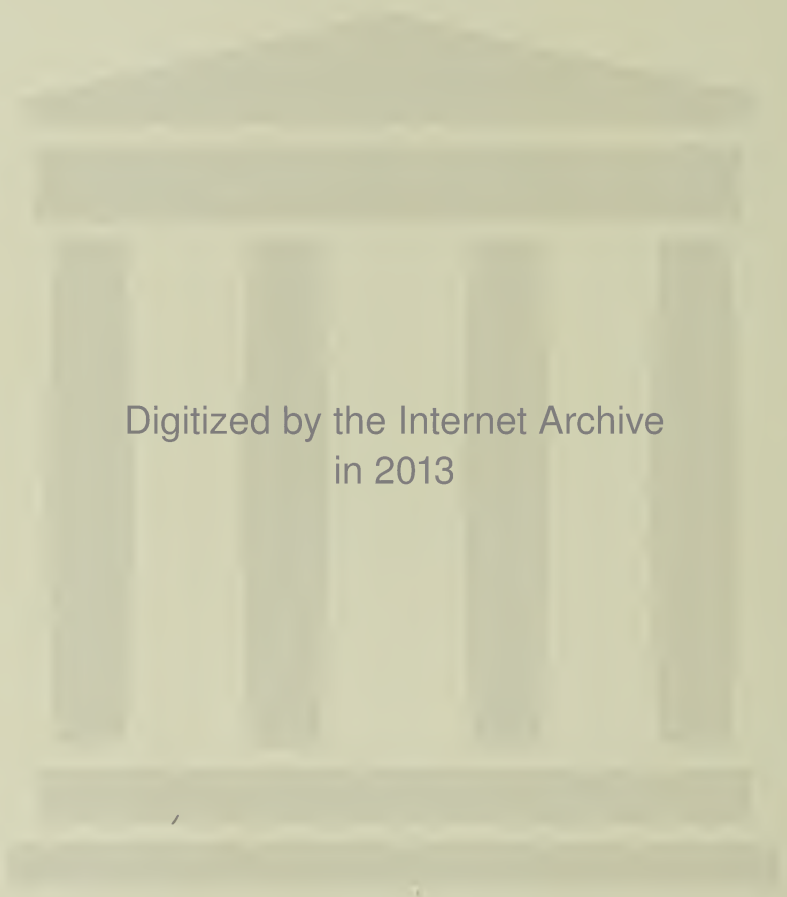
UNIVERSITY OF ILLINOIS

ANNOUNCEMENT OF THE
COLLEGE OF ENGINEERING



PUBLISHED BY THE UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

1940



Digitized by the Internet Archive
in 2013

C
IZe3Ic
1940

CONTENTS

	PAGE
Board of Trustees and Officers of Administration of the University	4
Members of the Faculty of the College of Engineering.....	5
History of the College of Engineering.....	10
Purposes and Scope of Instruction.....	12
Buildings, Libraries, Laboratories, and Equipment.....	18
Admission.....	40
Curricula and Degrees in Engineering.....	44
Courses Offered in the College of Engineering.....	59
Graduate Instruction and Research Work.....	78
General Information for Students.....	82
Living Accommodations.....	82
Annual Expenses.....	82
Student Health.....	83
Student Employment.....	84
Scholarships and Loan Funds.....	84
Prizes and Awards.....	85
Honors and Honorary Societies.....	85
Student Organizations and Activities.....	85
Physical Education and Athletics.....	87
Military Training.....	87
Who Should Study Engineering.....	89
Index.....	94

UNIVERSITY OF ILLINOIS

BOARD OF TRUSTEES

Members Ex Officio

HENRY HORNER, *Governor of Illinois*.....Springfield
JOHN A. WIELAND, *Superintendent of Public Instruction*.....Springfield

Elected Members

(Term 1935-1941)

OSCAR G. MAYER.....1241 Sedgwick Street, Chicago
Mrs. GLENN E. PLUMB.....4610 Drexel Boulevard, Chicago
HAROLD POGUE.....617 West Decatur Street, Decatur

(Term 1937-1943)

HOMER MAT ADAMS.....302 State Armory, Springfield
JAMES M. CLEARY.....310 South Michigan Avenue, Chicago
KENNEY E. WILLIAMSON.....Sixth Floor, Lehmann Building, Peoria

(Term 1939-1945)

FRANK A. JENSEN.....LaSalle
ORVILLE M. KARRAKER.....405 Centennial Building, Springfield
Dr. KARL A. MEYER.....Cook County Hospital, Chicago

Officers of the Board

HAROLD POGUE, *President*.....Decatur
HARRISON E. CUNNINGHAM, *Secretary*.....Urbana
FRANK M. GORDON, *Treasurer*.....First National Bank, Chicago
LLOYD MOREY, *Comptroller*.....Urbana

OFFICERS OF ADMINISTRATION

ARTHUR CUTTS WILLARD, B.S., D.Eng., LL.D., *President of the University*
ALBERT JAMES HARNO, B.S., LL.B., LL.D., *Provost, and Dean of the College of Law*
ROBERT DANIEL CARMICHAEL, Ph.D., *Dean of the Graduate School*
FRED HAROLD TURNER, Ph.D., *Dean of Men*
MARIA LEONARD, A.M., Litt.D., *Dean of Women*
GEORGE PHILIP TUTTLE, B.S., *Registrar*

MEMBERS OF THE FACULTY OF THE COLLEGE OF ENGINEERING

Officers of Administration

- MELVIN LORENIUS ENGER, M.S., C.E., Professor of Mechanics and Hydraulics, Dean of the College of Engineering, and Director of the Engineering Experiment Station
- HARVEY HERBERT JORDAN, B.S., Professor of General Engineering Drawing, Head of the Department, and Associate Dean of the College of Engineering

Professors*

- ARTHUR NEWELL TALBOT, C.E., D.Sc., D.Eng., LL.D., Professor of Municipal and Sanitary Engineering, *Emeritus*
- ALBERT PRUDEN CARMAN, D.Sc., Professor of Physics, *Emeritus*
- MORGAN BROOKS, Ph.B., M.E., Professor of Electrical Engineering, *Emeritus*
- ELLERY BURTON PAINE, M.S., E.E., Professor of Electrical Engineering and Head of the Department
- HERBERT FISHER MOORE, M.E., D.Sc., Research Professor of Engineering Materials
- OSCAR ADOLPH LEUTWILER, B.S., M.E., Professor of Mechanical Engineering Design and Head of the Department of Mechanical Engineering
- CULLEN WARNER PARMELEE, M.S., D.Sc., Professor of Ceramic Engineering and Head of the Department
- CHARLES TOBIAS KNIPP, Ph.D., Professor of Experimental Electricity, *Emeritus*
- FLOYD ROWE WATSON, Ph.D., Professor of Physics, *Emeritus*
- EVERETT EDGAR KING, M.S., M.C.E., Professor of Railway Civil Engineering
- ALONZO PLUMSTEAD KRATZ, M.S., Research Professor of Mechanical Engineering
- EDWARD CHARLES SCHMIDT, M.E., Professor of Railway Engineering, *Emeritus*
- FRED B. SEELY, M.S., Professor of Theoretical and Applied Mechanics and Head of the Department
- WILBUR M. WILSON, M.M.E., C.E., Research Professor of Structural Engineering
- HAROLD EATON BABBITT, M.S., Professor of Sanitary Engineering
- DONALD BABCOCK KEYES, Ph.D., Professor of Chemical Engineering[†]
- WHITNEY CLARK HUNTINGTON, M.S., C.E., Professor of Civil Engineering and Head of the Department
- JOHN STANLEY CRANDELL, B.S., C.E., Professor of Highway Engineering
- EVERETT GILLHAM YOUNG, M.S., M.E., Research Professor of Railway Mechanical Engineering
- CLARENCE WALTER HAM, M.E., Professor of Machine Design
- JOSEPH ALBERT POLSON, B.S., M.E., Professor of Steam Engineering
- CARL HERBERT CASBERG, B.S., M.E., Professor of Mechanical Engineering
- FRANCIS WHEELER LOOMIS, Ph.D., Professor of Physics and Head of the Department
- RALPH KENT HURSH, B.S., Professor of Ceramic Engineering
- JOSEPH TYKOCINSKI TYKOCINER, E.E., Research Professor of Electrical Engineering
- RANDOLPH PHILIP HOELSCHER, M.S., C.E., Professor of General Engineering Drawing
- HORACE JAMES MACINTIRE, M.M.E., Professor of Refrigeration
- GEORGE WELLINGTON PICKELS, B.C.E., C.E., Professor of Civil Engineering
- FRANK ERWIN RICHART, M.S., C.E., Research Professor of Engineering Materials
- WILLIAM H. SEVERNS, M.S., Professor of Mechanical Engineering
- HOWARD RICE THOMAS, C.E., M.S., Special Research Professor of Engineering Materials
- ANDREW IRVING ANDREWS, Ph.D., Professor of Ceramic Engineering
- JAMES JOSEPH DOLAND, M.S., C.E., Professor of Civil Engineering
- ABNER RICHARD KNIGHT, M.E., M.S., E.E., Professor of Electrical Engineering
- WILLIAM JAMES PUTNAM, M.S., M.E., Professor of Theoretical and Applied Mechanics
- THOMAS CLARK SHEDD, M.S., C.E., Professor of Structural Engineering
- JASPER OWEN DRAFFIN, M.S., Professor of Theoretical and Applied Mechanics

*Arranged in order of seniority of appointment.

[†]In charge of research investigations in chemical engineering in the Engineering Experiment Station.

JAMISON VAWTER, M.S., C.E., Professor of Civil Engineering
 CARROLL CARSON WILEY, B.S., C.E., Professor of Civil Engineering
 PETER GERALD KRUGER, Ph.D., Professor of Physics
 HENRY FRASER JOHNSTONE, Ph.D., Professor of Chemical Engineering¹
 HERBERT JOSEPH REICH, Ph.D., M.E., Professor of Electrical Engineering
 HUGH ALEXANDER BROWN, M.S., E.E., Professor of Electrical Engineering
 WILLIAM NELSON ESPY, M.S., Professor of Mechanical Engineering
 JOHN OTTO KRAEHNBUHL, M.S., E.E., Professor of Electrical Engineering

Associate Professors*

WILLIAM FREDERICK SCHULZ, E.E., Ph.D., Associate Professor of Physics, *Emeritus*
 MATTHEW RUTHERFORD RIDDELL, B.A.Sc., Associate Professor of Aeronautical Engineering and Assistant to the Director of the Engineering Experiment Station
 ELMER HOWARD WILLIAMS, Ph.D., Associate Professor of Experimental Physics
 NEWTON EDWARD ENSIGN, M.A., Associate Professor of Theoretical and Applied Mechanics
 ROBERT FREDERICK PATON, Ph.D., Associate Professor of Physics
 ERNEST ALEXANDER REID, M.S., E.E., Associate Professor of Electrical Engineering
 JOHN KLINE TUTHILL, B.S., E.E., Associate Professor of Railway Electrical Engineering
 EDWARD HARDENBERGH WALDO, M.S., E.E., Associate Professor of Electrical Engineering, *Emeritus*
 FREDERICK GUY STRAUB, M.S., Met.E., Special Research Associate Professor of Chemical Engineering
 JAMES HOLLEY BARTLETT, JR., Ph.D., Associate Professor of Theoretical Physics
 CHARLES ALVA KEENER, M.S., E.E., Associate Professor of Electrical Engineering
 CLIFFORD HARRY SPRINGER, M.S., C.E., Associate Professor of General Engineering Drawing
 SHERLOCK SWANN, JR., Ph.D., Research Associate Professor of Chemical Engineering
 MAURICE KENDALL FAHNESTOCK, M.S., Research Associate Professor of Mechanical Engineering
 HAROLD MEADE MOTT-SMITH, JR., Ph.D., Associate Professor of Physics
 HERMAN JOHN SCHRADER, M.S., Research Associate Professor of Applied Mechanics
 GERALD MARKS ALMY, Ph.D., Associate Professor of Physics
 DAVID GERALD RYAN, M.S., M.E., Associate Professor of Mechanical Engineering

Assistant Professors*

VIRGIL R. FLEMING, B.S., Assistant Professor of Theoretical and Applied Mechanics
 WILLIAM HORACE RAYNER, C.E., M.S., Assistant Professor of Civil Engineering
 FRANCIS MARION PORTER, M.S., Assistant Professor of General Engineering Drawing
 EDWARD EZRA BAUER, M.S., C.E., Assistant Professor of Civil Engineering
 PAUL EUGENE MOHN, M.S., M.E., Assistant Professor of Mechanical Engineering
 WILLIAM LOUIS SCHWALBE, M.S., Assistant Professor of Theoretical and Applied Mechanics
 FREDERICK HAYWARD THOMAS, M.S., Assistant Professor of Mechanical Engineering
 VERNON PETER JENSEN, Ph.D., Research Assistant Professor of Theoretical and Applied Mechanics
 CLIFFORD PROCTOR KITTREDGE, B.S., Dr.tech.Wis., Assistant Professor of Theoretical and Applied Mechanics
 WILLIAM ALBERT OLIVER, M.S., C.E., Assistant Professor of Civil Engineering
 THOMAS JAMES DOLAN, M.S., Assistant Professor of Theoretical and Applied Mechanics
 MAX ALBERT FAUCETT, M.S., E.E., Assistant Professor of Electrical Engineering
 ALBERT EBY HERSHEY, M.S., Research Assistant Professor of Mechanical Engineering
 SEICHI KONZO, M.S., Special Research Assistant Professor of Mechanical Engineering
 WALLACE MONROE LANSFORD, M.S., C.E., Assistant Professor of Theoretical and Applied Mechanics
 REINHOLD FRIDTJOF LARSON, M.S., Assistant Professor of Mechanical Engineering

*Arranged in order of seniority of appointment.

¹Cooperating in research investigations in the Engineering Experiment Station.

NATHAN MORTIMORE NEWMARK, Ph.D., Research Assistant Professor of Civil Engineering
LUTHER BUNYAN ARCHER, M.S., E.E., Assistant Professor of Electrical Engineering
RALPH ELLSWORTH CRAMER, M.S., Special Research Assistant Professor of Engineering Materials
ALBERT JORGENSEN, M.S., E.M., Assistant Professor of General Engineering Drawing
HUGH PHILO NICHOLSON, M.S., E.M., Assistant Professor of Mining Engineering
CARL ERIC SKRODER, M.S., Assistant Professor of Electrical Engineering
MORITZ GOLDBABER, Ph.D., Assistant Professor of Physics
HAROLD LEROY WALKER, M.S., Met.E., Assistant Professor of Metallurgical Engineering and Acting Head of the Department of Mining and Metallurgical Engineering
JOHN REGINALD RICHARDSON, Ph.D., Assistant Professor of Physics
ROBERT SERBER, Ph.D., Assistant Professor of Physics
STANLEY GILBERT HALL, M.S., Assistant Professor of General Engineering Drawing
CARL EDWARD SCHUBERT, B.S., Assistant Professor of Mechanical Engineering
JULIAN ROBERT FELLOWS, M.S., Assistant Professor of Mechanical Engineering
WILLIAM LEIGHTON COLLINS, M.S., Assistant Professor of Theoretical and Applied Mechanics
LELAND JOHN HAWORTH, Ph.D., Assistant Professor of Physics
WALTER HERBERT BRUCKNER, A.B., Ch.E., Research Assistant Professor of Metallurgical Engineering
JOHN LOUIS G. WEYSER, B.S., E.M., Assistant Professor of Mining Engineering
ALFRED EARL BADGER, Ph.D., Research Assistant Professor of Ceramic Engineering

Associates*

BURRILL RUPERT HALL, Associate in Mechanical Engineering, *Emeritus*
EDGAR THOMAS LANHAM, Associate in Mechanical Engineering, *Emeritus*
RALPH STUART CROSSMAN, C.E., M.S., Associate in General Engineering Drawing
JOHN FRANK WOODDELL, M.S., Associate in Mechanical Engineering
GEORGE HARPER DELL, M.S., C.E., Associate in Civil Engineering
HAROLD NATHANIEL HAYWARD, M.S., Associate in Electrical Engineering
LAURENCE LEWIS SMITH, M.S., Associate in Electrical Engineering
CHARLES JOSEPH STARR, B.S., Associate in Mechanical Engineering
LEONARD DILWORTH WALKER, M.S., C.E., Associate in General Engineering Drawing
RALPH WENDEL KLUGE, M.S., Special Research Associate in Theoretical and Applied Mechanics
HENRY PRITCHARD EVANS, JR., M.S., Associate in Civil Engineering
ALPHONSE ANTHONY BRIELMAIER, M.S., C.E., Associate in Civil Engineering
REN LENOX BROWN, M.S., Associate in Theoretical and Applied Mechanics
JAMES THOBURN LENDRUM, B.S., Associate in General Engineering Drawing
JOHN HENRY MANLEY, Ph.D., Associate in Physics
EDWARD W. SUPPGER, M.S., Associate in Theoretical and Applied Mechanics
ROBERT DOWNES WILLIAMS, M.S., Associate in Mechanical Engineering
EDWARD BRENT JORDAN, JR., Ph.D., Associate in Physics
WILLIAM JOSEPH WARREN, Ph.D., Associate in Electrical Engineering
NORVILLE JAMES ALLEMAN, M.S., Special Research Associate in Engineering Materials
JOSEPH LOUIS BISESI, M.S., E.E., Special Research Associate in Engineering Materials
ERNEST MCINTOSH LYMAN, Ph.D., Associate in Physics
KENNETH JAMES TRIGGER, M.S., Associate in Mechanical Engineering
ELMER FRANKLIN HEATER, B.S., Research Associate in the Engineering Experiment Station
EDWARD ARTHUR PARKER, Ph.D., Special Research Associate in Chemical Engineering
RICHARD HENRY BOLT, Ph.D., Associate in Physics
NORMAN FOSTER RAMSEY, JR., Ph.D., Associate in Physics
WARREN SKINNER HARRIS, M.S., Special Research Associate in Mechanical Engineering

Instructors*

AMOS DAVID WRIGHT, Instructor in Mechanical Engineering
GEORGE ROBERT FINK, B.S., Instructor in General Engineering Drawing

*Arranged in order of seniority of appointment.

JAMES GORDON CLARK, M.S., Instructor in Civil Engineering
 CAMERON GERALD HARMAN, Ph.D., Instructor in Ceramic Engineering
 STANLEY HOLT PIERCE, M.S., Instructor in General Engineering Drawing
 GILBERT HOWARD FETT, M.S., Instructor in Electrical Engineering
 HARRY WALLACE HORN, M.S., Instructor in Electrical Engineering
 EDWARD LOUIS BROGHAMER, B.S., Instructor in Mechanical Engineering
 PAUL GUY JONES, B.S., Instructor in Theoretical and Applied Mechanics
 JOHN CLEM MILES, B.S., Instructor in Mechanical Engineering
 LLOYD BUTLER RITCHEY, B.S., Instructor in General Engineering Drawing
 JAMES OHREA SMITH, A.M., Instructor in Theoretical and Applied Mechanics
 JACK PHILLIP Co VAN, B.M.E., B.I.E., Instructor in Mechanical Engineering
 WARREN EUGENE COMPTON, M.S., Instructor in Mechanical Engineering
 CHARLES THERON GRACE, B.S., Instructor in Mechanical Engineering
 JOSEPH ADAM PASK, M.S., Instructor in Ceramic Engineering
 WINSTON EDWARD BLACK, M.S., Instructor in Theoretical and Applied Mechanics
 MARION STANLEY HELM, M.S., Instructor in Electrical Engineering
 BERNT OSCAR LARSON, B.S., Instructor in General Engineering Drawing
 JAY ARTHUR BOLT, B.S., M.M.E., Instructor in Mechanical Engineering
 DONALD WILLIAM KERST, Ph.D., Instructor in Physics
 FRANCIS LOUIS EHASZ, M.S., Instructor in Theoretical and Applied Mechanics
 MARIO JOSEPH GOGLIA, M.E., Instructor in Mechanical Engineering
 EDWIN DEVERE LUKE, M.S., Instructor in Mechanical Engineering
 FRANCIS SEYFARTH, B.S., Instructor in Mechanical Engineering
 RALPH LAVERNE COOK, B.S., Instructor in Ceramic Engineering
 JAMES CURTIS MACE, JR., M.S., Instructor in Electrical Engineering
 GEORGE ROLAND PEIRCE, M.S., Instructor in Electrical Engineering
 JAMES HENRY SMITH, E.E., M.S., Instructor in Electrical Engineering
 JOHN EDWIN PEARSON, B.S., Instructor in General Engineering Drawing
 DONALD HEATHFIELD KRANS, M.S., Instructor in Mechanical Engineering
 EARL JOSEPH ECKEL, B.S., Instructor in Metallurgical Engineering
 BERNARD GORDON RICKETTS, M.S., Instructor in Metallurgical Engineering
 JOHN ALDEN SNYDER, B.S., Instructor in Metallurgical Engineering
 WILLIAM NICHOLS FINDLEY, M.S., Instructor in Theoretical and Applied Mechanics
 LYLE WINSTON PHILLIPS, Ph.D., Instructor in Physics
 MORTON HENRY KANNER, Ph.D., Instructor in Physics
 SIDNEY MICHAEL DANCOFF, Ph.D., Instructor in Physics

Assistants†

JOHN WINFIELD ALLEN, B.S., Special Research Graduate Assistant in Theoretical and Applied Mechanics
 GEORGE CURRIDEN BALDWIN, A.B., Assistant in Physics
 FRANCE BARNET BERGER, M.S., Assistant in Physics
 LOUIS RICHARD BLOOM, B.S., Research Assistant in Electrical Engineering
 EDWIN LAURENCE BRODERICK, M.S., Research Assistant in Mechanical Engineering
 DAVID HUME CALDWELL, B.S., Special Research Graduate Assistant in Civil Engineering
 ROBERT KENLEY CLARK, A.B., Assistant in Physics
 NORMAN DAVID COGGESHALL, M.S., Assistant in Physics
 JOHN VAN VEGHTEN COOMBE, M.S., Special Research Assistant in Civil Engineering
 CHESTER EDWARD DERROUGH, Assistant in Mechanical Engineering
 CURTIS WALTER DOLLINS, M.S., Special Research Assistant in Engineering Materials
 WARREN GILBERT DUGAN, B.S., Research Graduate Assistant in Theoretical and Applied Mechanics
 RICHARD BOTT ENGDAHL, M.S., Special Research Assistant in Mechanical Engineering
 GEORGE ROYCE GAMERTSFELDER, M.S., Assistant in Physics
 ROBERT GIBSON, B.S., Assistant in Electrical Engineering
 WILLIAM EARL GOOD, M.S., Assistant in Physics
 EVERETT BURTON HALES, M.S., Assistant in Physics
 BURNHAM WILLIAM KING, JR., Ph.D., Special Research Assistant in Ceramic Engineering
 GEORGE STANLEY KLAIBER, A.B., Assistant in Physics

†Arranged alphabetically.

JOHN KODIS, A.B., Assistant in Physics
VERNON MORRIS KORTY, A.M., Assistant in Physics
ROLAND FREDERICK KRUEGER, A.B., Assistant in Physics
RICHARD WAYNE LEE, A.M., Assistant in Physics
KEITH CARSON LOWE, B.S., Special Research Assistant in Theoretical and Applied Mechanics
STUART WELLINGTON LYON, M.S., Special Research Assistant in Engineering Materials
DANIEL WILLIAM MARTIN, M.S., Assistant in Physics
CYRIL ELWIN MCCLELLAN, M.S., Assistant in Physics
WILLIAM LOCKWOOD PARKER, A.M., Assistant in Physics
WARREN MONROE PECKHAM, B.S., Special Research Graduate Assistant in Theoretical and Applied Mechanics
ROBERT LAMAR PIGFORD, B.S., Research Graduate Assistant in Chemical Engineering
SAM SACHS, B.S., Research Assistant in Mechanical Engineering
ALANJIT DHALIWAL SINGH, M.S., Special Research Assistant in Chemical Engineering
HOWARD ROY STOVER, B.S., Research Graduate Assistant in Mechanical Engineering
CLARENCE BENJAMIN WILLIAMS, JR., B.S., Special Research Graduate Assistant in Theoretical and Applied Mechanics
GEORGE HERBERT ZINK, B.S., Assistant in Ceramic Engineering
HOWARD RAYMOND SWIFT, B.S., Research Graduate Assistant in Ceramic Engineering
HAROLD CRATE, B.S., Research Graduate Assistant in Civil Engineering
HOWARD ALLEN LEITER, A.B., Assistant in Physics
CHARLES JOEL TAYLOR, JR., B.S., Assistant in Physics
GAIL DAYTON ADAMS, JR., Assistant in Physics
FRANK NEWTON GILLETTE, B.S., Assistant in Physics
WILLIAM ELWOOD OGLE, A.B., Assistant in Physics
ELMER LEROY YOUNKER, A.B., Assistant in Physics
PHILIP ROGER GILLETTE, A.B., M.S., Assistant in Physics
THEODORE ALLEN WELTON, B.S., Assistant in Physics
FRANCIS KASPER TALLMADGE, B.S., Research Graduate Assistant in Physics
OSBORN CARROLL WORLEY, B.S., Research Graduate Assistant in Theoretical and Applied Mechanics
DOUGLAS EMERIT DREIER, B.S., Special Research Graduate Assistant in Civil Engineering
JOHN EDWARD DUBERG, B.S., Special Research Graduate Assistant in Civil Engineering
JOHN CORNELIUS HOUBOLT, B.S., Special Research Graduate Assistant in Civil Engineering
LAWRENCE EUGENE GOODMAN, A.B., B.S., Special Research Graduate Assistant in Civil Engineering
HOWARD CARL BEEDE, B.S., Special Research Graduate Assistant in Metallurgical Engineering
ROSS J. MARTIN, B.S., Special Research Assistant in Mechanical Engineering
GEORGE WILSON DICKINSON, B.S., Assistant in Metallurgical Engineering

Librarian

HILDA JOSEPHINE ALSETH, A.B., B.L.S., Librarian in the Engineering Library

MEMBERS OF THE DEPARTMENT OF AGRICULTURAL ENGINEERING IN THE COLLEGE OF AGRICULTURE

Cooperating with the College of Engineering

EMIL WILHELM LEHMANN, B.S., E.E., A.E., Professor of Agricultural Engineering and Head of the Department
WILLIAM A. FOSTER, B.S., B.Arch., A.E., Associate Professor of Rural Architecture
RAY IRIS SHAWL, M.S., Associate Professor of Agricultural Engineering
ARTHUR LEIGHTON YOUNG, M.S., Assistant Professor of Agricultural Engineering
RUSSELL HARLAN REED, B.S., Associate in Agricultural Engineering
EDWIN LEROY HANSEN, B.S., Assistant in Agricultural Engineering
ROBERT FRANKLIN SKELTON, B.S., Assistant in Agricultural Engineering

History of the College of Engineering

THE COLLEGE OF ENGINEERING of the University of Illinois was organized in 1870, and provided for "courses in Mechanical Science and Art, Civil Engineering, Mining Engineering and Metallurgy, and Architecture and Fine Arts." Definite four-year curricula were published in 1871-1872: Architecture, Civil Engineering, Mechanical Engineering, and Mining Engineering. Instruction in the University, then the Illinois Industrial University, began in March, 1868. The first class, which was graduated in 1872, contained six candidates from the College of Engineering—one in Architecture, four in Civil Engineering, and one in Mining Engineering.

The early years of the college were characterized by steady growth, both in the number of students enrolled and in the development of means and methods of effective instruction. From 1885 to 1911, the enrollment in the College of Engineering was more than half that of the men students in the whole University. This steady increase in enrollment reached a peak of 1297 students in 1909.

Then followed a ten-year period of approximately constant enrollment, ending with a registration of 925 students in 1918-1919, during the World War. From a post-war enrollment of 1810 students in the fall of 1919, the college moved gradually downward to an enrollment of 1475 in 1923, and then upward to an all-time high of 1989 students in 1930. During the summer of 1931, the Department of Architecture was transferred to the newly organized College of Fine and Applied Arts, thereby reducing the enrollment in the College of Engineering by approximately 450 students. The enrollment in the winter of 1939-1940 was 1809 students.

In 1892, three new curricula were added to the four originally established in 1870, namely, Electrical, Municipal and Sanitary, and Architectural Engineering. Then followed the curricula in Railway Engineering in 1906, Ceramics and Ceramic Engineering in 1915, General Engineering and Engineering Physics in 1920, and Agricultural and Metallurgical Engineering in 1933. The Department of Physics had been established as an independent department in the college in 1890.

The Department of Railway Engineering was dissolved in 1940, and the courses of its three curricula were reorganized and distributed among the departments of Civil, Electrical, and Mechanical Engineering.

The college was exceedingly fortunate in the personnel of its departments in the early stages of its development. Stillman W. Robinson, the first teacher in the new college, was appointed Professor of Mechanical Engineering in December, 1869, and served eight and one-half years in that capacity. He established the first strictly educational shops in the United States. His clear-cut ideas of the aims of engineering education in this country dominated the early development of the college and determined a philosophy of education considered sound in present-day programs. Mathematical theory and scientific research were admirably blended with discussions of engineering practice in Professor Robinson's classroom and laboratory.

Professor Robinson was associated with and followed by a group of pioneers in this almost new type of education. Among them may be men-

tioned: Professor Selim H. Peabody, in Mechanical Engineering, later elected regent of the University; J. Burkitt Webb and Ira O. Baker, in Civil Engineering; N. Clifford Ricker, in Architecture; Arthur T. Woods and Lester P. Brekenridge, in Mechanical Engineering; Arthur N. Talbot, in Municipal and Sanitary Engineering; Theodore B. Comstock, in Mining Engineering; and Samuel W. Stratton and Albert P. Carman, in Physics. The impress of these early educational pioneers upon engineering education in this country clearly persists to this day in many institutions and in professional practice.

Contrasted with a faculty of seventeen professors and assistant professors and the equivalent of twelve instructors and assistants in 1900, the faculty of the College of Engineering in 1940 numbered 83 men of professorial rank, 60 associates and instructors, and 28 assistants, or a total of 171 persons of all ranks, exclusive of the staff of the Engineering Experiment Station.

The development of the college in a physical sense is illustrated by its growth from a single shop building and classroom space in another structure in 1895, to a well-integrated campus of thirteen spacious and modern buildings in 1940, containing about 50 classrooms, 25 drafting rooms, 70 laboratories, and adequate supply, storage, instrument, and other auxiliary rooms. Included in these quarters is an engineering library of 40,000 volumes, with a subscription list of 400 current engineering magazines and periodicals, to serve the needs of students and faculty for standard technical literature and current engineering writing. The value of the equipment in the laboratories and shops was more than \$1,200,000 in 1940.

The Engineering Experiment Station, the first in any engineering college in the United States, was established in 1903. It has published about 360 bulletins and circulars on important researches in many fields of engineering science and practice. The staff of the station in 1940 consisted of approximately 18 permanent and 29 temporary workers. All members of the instructional staff of the college are also considered members of the station for purposes of promoting individual and group investigations.

Purposes and Scope of Instruction

THE CURRICULA of study in the College of Engineering, as well as the individual classroom and laboratory instruction, are based on the well-known fact that successful professional practice in engineering depends primarily on a thorough knowledge of the principles of the mathematical and physical sciences and of their applications in the design, construction, and operation of engineering and industrial works. For this reason, the curricula of the college, outlined in later pages, are fundamentally scientific in character for the first three years, with a common core of subject matter in the first two years. Sufficient practice in the application of principles in design and operation is required in the fourth year to make the student's knowledge applicable in his later engineering work. A moderate amount of specialization is provided through options, or special arrangements of courses, in the senior year. It is held that real specialization must be built on a thorough groundwork of fundamental training in science, and is best carried on through graduate study, for which abundant opportunity is provided by the University. A carefully arranged five-year program of undergraduate study also permits specialization and at the same time provides opportunity for broadening the student's viewpoints in fields allied to his specialty.

The necessary skills and techniques of manipulation and graphical expression are taught in intensive courses early in the curricula. A thorough command of written and oral English is deemed essential in the engineer's training, and substantial work in this field is required. The social, economic, and esthetic implications of the engineer's work are presented to the student through the regular classroom instruction and by means of formal non-technical courses in the College of Engineering and in other departments of the University.

Correct professional attitudes are acquired by young men through close personal association with members of the faculty of broad engineering experience; through studies of codes of professional ethics, addresses, and biographies of engineers; and through employment on engineering work under men of character and high professional ideals. The student's personality and qualities of leadership as well as his interest in, and understanding of, human behavior under varying conditions—factors of great importance in engineering practice—are developed through extra-curricula activities of many sorts. Typical of the college and university organizations sponsoring these activities under faculty guidance may be cited the student chapters of the national engineering societies, university musical and dramatic clubs, intra-mural and collegiate debating teams, college and university publications, the Reserve Officers Training Corps, intra-mural and inter-collegiate athletics, literary societies, fraternities, and other social organizations.

The trained and experienced engineer is peculiarly fitted to assume leadership in business activities having to do with manufacturing, transportation, communication, and construction. He must attain his place of preeminence in these fields by a mastery of their technology through actual experience. It is recognized, however, that certain fundamentals of management and administration can be learned in a college classroom; hence, in several cur-

ricula, options in administration are offered, particularly in the mineral industries group. The curriculum in General Engineering furnishes an opportunity in this direction as well as in other fields not covered by the classifications of the older curricula.

The place of the engineer in the public service has always been recognized as an important one. In recent years, the employment of his services in this direction has greatly increased. More than five thousand engineers were in professional and scientific positions in government offices under United States Civil Service classifications during the year ending in June, 1930, by far the largest professional group under such classification. The College of Engineering has provided postgraduate one-year programs of study for persons holding bachelor's degrees in engineering who wish to prepare themselves definitely for the public service. A certain part of the program can be accomplished for credit in the undergraduate curriculum. The College of Engineering maintains outlines of courses suited to various circumstances of preparation, supplementing the publication entitled *University Training for the Public Service*.

The college administers its curricula and carries out its functions of instruction and research through the medium of nine separate but well-coordinated departments, seven of which offer curricula leading to the degree of Bachelor of Science, with designation of the course pursued. Two curricula are administered directly by the dean of the college, namely, Agricultural Engineering and General Engineering, the first in close cooperation with the College of Agriculture, the second as an independent curriculum with somewhat less emphasis on technical design than the standard curricula impose. The curriculum in Chemical Engineering is administered by the College of Liberal Arts and Sciences. A brief statement of the specific purposes and scope of the curricula and work done in each of these departments follows.

Students of high scholastic achievement, with exceptional aptitudes and interests in special fields of engineering science and application, may be permitted to vary the course content of the standard curriculum of the department in which they are registered, with the purpose of emphasizing some phases of the general area of knowledge which are not included in the standard curriculum or which cannot be encompassed by the usual procedure of course substitution and selection of electives. These unwritten curricula, however, include all of the fundamental underlying courses of the standard curricula, the variations being made mainly in the so-called "applicatory" portions of the standard curricula of the college. The program of studies of each student permitted to take such a dual curriculum must be approved by a committee of the college, of which the associate dean is chairman, in consultation with the head of the department in which the student is registered and with a professor of the college particularly interested in the field which the student intends to emphasize. This professor automatically becomes the student's adviser in charge of registration and other matters pertaining to the proper carrying out of the approved program.

Agricultural Engineering.—The curriculum in Agricultural Engineering is provided for students who plan to enter teaching, research, or design work in this rapidly widening field. The scope of the ground covered can be visualized under four main headings: (1) *Power and machinery*, in-

cluding consideration of the types available and applicable to farm life; the design and development of implements, machines, vehicles, and other equipment; and the development and use of various suitable materials of construction. (2) *Farm electrification*, including the extension of electrical service to the rural areas; and the development and use of the electrical farm machinery and equipment involved in the program of more extensive utilization of electricity in agriculture. (3) *Farm buildings and other structures*, including the design, location, and arrangement of farm structures of all kinds; the proper lighting, heating, and ventilating of farm buildings; and the provisions for refrigeration equipment, water supplies, and sewage disposal structures. (4) *Land reclamation and use*, including irrigation, drainage, soil erosion, flood control, land clearing, and general farm improvement. The entire curriculum is fundamentally an engineering program, with moderate specialization beginning in the second year. Two options are provided: one a power and machinery option, the other a drainage and structures option, as outlined in the formal curriculum printed on following pages. The College of Agriculture has an assortment of tractors, gas engines, and farm machinery for student use. Lighting units and water systems are provided in the home-equipment laboratory, and there are modern facilities for concrete construction. The courses designated as Agricultural Engineering (Agr. Eng.) in the curriculum are offered by the College of Agriculture. The curriculum is administered by the College of Engineering, and the degrees are awarded upon certification by its faculty. The cooperative features described provide the student with the dual advantages of close contact with the staffs and facilities of both colleges.

Ceramic Engineering.—Two curricula are offered in the Department of Ceramic Engineering leading to the degree of Bachelor of Science, one in Ceramics and the other in Ceramic Engineering. The courses as a whole prepare the student in the general scientific principles underlying the silicate industries, which include the manufacture of glass, vitreous enamels for metals, refractories, cements, and clay products such as pottery, structural materials, sanitary ware, electrical porcelain, abrasives, etc. The curriculum in Ceramic Engineering prepares the student for the designing of plants and equipment, the construction of kilns and driers, and the supervision of manufacturing operations. It is distinctly an engineering course in which engineering subjects predominate. An administration option is offered those registered in Ceramic Engineering who wish to engage in salesmanship or management in the industry. This option contains courses in accounting, management, salesmanship, cost accounting, etc., which are substituted for some of the electives and required courses in the strictly technical curriculum.

Chemical Engineering.—The courses in Chemical Engineering (administered by the Department of Chemistry in the College of Liberal Arts and Sciences) prepare men to evaluate the results obtained in the laboratory and to translate them, through a series of development stages, into commercial large-scale processes; to improve existing plants; to develop new commercial products; to design new equipment; and to operate and supervise plants in which chemical processes take place. The curriculum offers a thorough training in the fundamental sciences of chemistry, mathematics, and physics, and their application to industry in a wide variety of fields.

The Chemical Engineering laboratories are housed in the Noyes Laboratory of Chemistry and in several smaller buildings constructed for special investigations. The equipment in these laboratories is extensive, and in addition other equipment of the Department of Chemistry is available for use of students in the curriculum in Chemical Engineering.

Civil Engineering.—The courses in the Department of Civil Engineering offer a systematic training in the principles underlying the design and construction of bridges, buildings, dams, retaining walls, and similar structures; of highways; of water supply and sewage disposal systems; and of hydraulic engineering works; and in the principles of city and regional planning. Opportunity is offered in the senior year for a certain amount of specialization in some of the more important branches of civil engineering through options in structural, highway, hydraulic, railway civil, and sanitary engineering.

Electrical Engineering.—The Department of Electrical Engineering offers a curriculum in the theory of applied electricity. The first two years of work are substantially the same as in other engineering curricula, including work in drafting room and shop, and instruction in the principles of Chemistry, mathematics, mechanics, and physics. In the second year, a course in commercial and industrial wiring and illumination is offered. In the third year, a course in direct and alternating current circuits is followed by the theory of direct current machines, with laboratory courses which emphasize principles. An elementary course in electronics is given. Technical courses covering the generation, transmission, and distribution of electric power, and its various applications, are offered in the fourth year, together with courses covering advanced electronics and radio communication. The technical courses are accompanied by laboratory experiments and demonstrations. Investigations of problems of power distribution and control, and of communication are made in advanced laboratory and thesis work. The electronics, radio, and illumination laboratories are well equipped.

General Engineering.—This curriculum provides a fundamental engineering training with moderate emphasis on design and a fixed requirement of eighteen credit hours in economics, corporations, finance, business law, and labor problems. Specialization in any field of the student's choice is permitted in the liberal provisions for elective studies to the extent of one-eighth the total requirements for the degree. The curriculum is intended for those who do not care to follow the more technical phases of engineering practice but who desire to ally themselves with industrial and commercial development in the fields of management, operation, and construction—preparation for which is most securely founded on scientific and engineering facts and disciplines, supplemented by economic and social orientations.

General Engineering Drawing.—The courses in this department are intended to develop the theory, skill, and technique needed for the preparation and understanding of engineering plans and designs by means of the graphical language. Both orthographic and pictorial forms of representation are covered in elementary and advanced courses. The work in descriptive geometry is well coordinated with the drawing courses and with practical problems in engineering. The constant use of methods of exact geometrical analysis necessarily employed in this subject, combined with the steady de-

velopment of the student's powers of reasoning and visualization, furnishes him a background of great value in his later study of engineering problems.

Mechanical Engineering.—The courses in the Department of Mechanical Engineering are planned to present the theory and practice of the generation and transmission of power, and of the design, construction, operation, and testing of machinery of all kinds. In the laboratories, emphasis is given to the engineering and economic principles of machine operation, performance, and construction, and to problems of scientific shop management. Through a wide choice of electives, there is opportunity for an introduction to such subjects as economics, political science, industrial organization, and business management. Technical subject options in the senior year give the student an opportunity to follow his interest in one of several fields, such as heat engineering, industrial administration, aeronautical engineering, refrigeration engineering, heating, ventilating, and air conditioning. Curriculum options in petroleum production engineering and in railway mechanical engineering are also provided.

Mining and Metallurgical Engineering.—The Department of Mining and Metallurgical Engineering offers courses of instruction to train men for various phases of the mineral industry. There are two curricula—Mining Engineering and Metallurgical Engineering.

Mining Engineering.—The curriculum in Mining Engineering has four options: Coal Mining, Ore Mining, Mining Geology, and Mine Administration. In each of these the basic mining curriculum is retained, a proper arrangement of electives permitting the selection of a particular option without sacrificing fundamentals. To this end the regular engineering fundamentals are retained, and the department adds specialized work in mine surveying, mining methods, prospecting, mine examination, hoisting and haulage, mine ventilation, coal washing and ore dressing, mine administration, and the design of mining plants.

Metallurgical Engineering.—This curriculum is planned to present the fundamentals of the science of modern metallurgy, maintaining a proper balance between the two main divisions—process metallurgy and physical metallurgy. It is intended to prepare the student for entrance, on graduation, into either branch of the industry, and to afford those whose interest lies in advanced study and research a broad foundation for the successful prosecution of graduate work in metallurgy. To the preliminary courses in mathematics, physics, chemistry, general engineering drawing, and mechanics, common to all curricula in engineering, specialized courses are added in physical chemistry, principles of metallurgy, physical metallurgy, ferrous and non-ferrous metallurgy, metallography, electro-metallurgy, and metallurgical design.

Physics.—Besides offering the customary service courses in general physics for various groups of students in the College of Engineering and elsewhere in the University, the Department of Physics offers a curriculum in Engineering Physics, designed to give students the broad and thorough training in fundamental physics and mathematics which is demanded by the increasing complexity of modern engineering practice. The work of the first two years is much like that in the other engineering curricula; in the last two years advanced courses in physics, mathematics, and chemistry are

emphasized, but there is a liberal allowance of time for the study of any field of engineering in which the student is especially interested. The details of technical applications are left to be learned in connection with a particular job; or, if the electives are properly selected, the curriculum may be made a basis for graduate work in some particular field of engineering or in physics. The department is well provided with the equipment and facilities for carrying on research in numerous fields of modern physics.

Railway Engineering.—The courses in railway engineering are organized to train students for service in the technical departments of railways. The special subjects in railway *civil* engineering concern the location, design, construction, and maintenance of track and equipment, and the design of railway structures. The courses in railway *electrical* engineering deal with the design and construction of electric railway equipment, the operation and performance of electric cars and locomotives, and the problems which arise in the electrification of steam lines. The courses in railway *mechanical* engineering adds to the fundamentals of the general mechanical engineering curriculum special courses on the design of locomotives and cars, the resistance of trains, the performance and tests of locomotives, and tests of railway equipment.

Theoretical and Applied Mechanics.—Courses in theoretical and applied mechanics are required in all the engineering curricula. The purpose of the courses is to teach the student to analyze and solve engineering problems by applying the principles of mathematics and of physics to conditions as they arise in the design, construction, and operation of engineering structures and machines. In the well-equipped laboratories the student tests many engineering materials, such as steel, brass, aluminum, timber, and concrete, to determine the various properties that are needed in the use of the materials in design and construction, and in the writing of specifications for the materials. In the hydraulics laboratory he performs experiments on the flow of water in pipes and open channels, and determines the operating characteristics of different kinds of pumps and turbines. A number of advanced courses in the analysis of stresses in materials, in testing of materials, and in hydraulics are offered, which may be elected by junior and senior students. A large amount of research work is carried out in the laboratories, some of which involves tests of large members. A 3,000,000-pound testing machine is available for this work. Students are encouraged to follow the progress of this investigational work.

Buildings, Libraries, Laboratories, and Equipment

THE BUILDINGS of the College of Engineering form a compact group on the north campus of the University (see map inside back cover). In these buildings are located the classrooms, laboratories, and drafting rooms most used by students enrolled in the engineering curricula. Immediately to the south, in buildings on the middle campus, are the classrooms and laboratories of the College of Liberal Arts and Sciences, so much frequented by engineering students in their first two years of work. The close daily contact of students of all four classes in the College of Engineering, from the freshman year through the senior year, develops their common interests and a spirit of college unity and professional morale. Their interests are broadened, at the same time, through contact with students in other colleges of the University, in classrooms on other parts of the campus.

Libraries

The Engineering Library occupies two floors of the north wing of Engineering Hall and provides ample reading-room and book-shelf facilities with individual study tables for faculty members and graduate students. This library contains 40,000 volumes, including books, bound volumes of magazines, and publications of engineering societies. It has also a large number of pamphlets, several thousand lantern slides, and a collection of Manufacturers' Catalogs, including "Catalog Studies," which is kept up to date by subscription. Over 400 technical magazines and publications of engineering societies are currently received. It has built up a good collection of biographies of engineers and of early books on engineering. Its collections of early books on mechanics and strength of materials, on railways, and on the telephone and telegraph are considered by some to be among the best in the country. It has a small collection of books for general reading, including a collection of "engineering fiction," of popular books in science, and of books on vocational guidance along engineering lines. It has an excellent collection of general technical dictionaries in the several foreign languages, with definitions in English, as well as similar dictionaries in special fields of engineering. Each year, important books and sets on engineering in foreign languages as well as in the English language are added to the library.

This library is supplemented by several specialized, or departmental, libraries of a scientific and engineering nature. Notable among these are the libraries in Ceramics and Ceramic Engineering, Chemistry and Chemical Engineering, Physics, and Mathematics.

The Ockerson collection of books on River Improvement, which was a part of the private library of the late John A. Ockerson of the Class of 1873, was presented to the University of Illinois by Mrs. Ockerson in 1924, and is housed in the Engineering Library.

To aid in reference and research work, the Engineering Library has complete sets of the Engineering Index, the Industrial Arts Index, Chemical Abstracts, Science Abstracts, Bibliographic Index, Building Science Abstracts, Engineering Abstracts, Highway Research Abstracts, International



THE MAIN FLOOR OF THE ENGINEERING LIBRARY

Bibliography of Engineering and Industry, Japanese Journal of Engineering Abstracts, Public Health Engineering Abstracts, Road Abstracts, Summary of Current Literature on Water Pollution Research, and *Zentrallblatt für Mechanik*, as well as indexes to individual sets of magazines, publications of societies and other series. Many other bibliographical aids in related fields are in the University Library.

Much engineering material is housed in the general University Library containing over a million volumes, and this includes such material as the original studies and computations of the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals in Chicago, the Final Report in bound form being kept in the Engineering Library. Many of the engineering publications of state, federal, and foreign governments are also in the University Library.

Laboratories

The laboratories of the College of Engineering are numerous and well-equipped. The laboratories used in research are not entirely separated from those used in the instructional work. Thus the student is brought into desirable contact with this important part of the college program while he is still doing his undergraduate work. In many instances temporary laboratories are set up for special research projects, and laboratories in other parts of the country are used in some investigations.



THE POTTERY-MOLD LABORATORY

The following descriptions of the laboratories and equipment of the college, arranged in the alphabetical order of departments, are intended to furnish the reader with sufficient information on which to base a judgment of the adequacy of the physical facilities for both instruction and research. Additional details will be supplied by the dean of the college or by the head of any department on request.

Ceramic Engineering Laboratories and Equipment

The laboratory facilities of the Department of Ceramic Engineering include the following: the general ceramic laboratories; separate laboratories for pottery, enamels, structural clay products, microscopy, and drying; a kiln laboratory; research laboratories; a museum; and a library.

Ceramic Laboratories.—The laboratory courses in raw materials, bodies glazes, and enamels are conducted on the first floor of the Ceramics Building, where facilities are provided for sixty students. These laboratories contain all the apparatus and equipment usually required for the grinding and the pulverizing of materials for the study of physical properties, and for testing pottery, glasses, glazes, and enamels.

Pottery Laboratory.—The pottery laboratory is used for instruction in the preparation of body mixtures, for demonstration and practice in the various methods of pottery production, and for the making of special articles used for class and research work. The slip house and molding equipment is very complete. The shop for demonstrating the making of plaster molds, for jiggering, casting, or pressing wares, contains jollys, layout tables, whirlers, and lathe.



THE KILN LABORATORY

Enamel Laboratory.—This laboratory is equipped for instruction and research in all branches of vitreous enameling. There is installed equipment for chemical cleaning, pickling, annealing, scaling, and sandblasting of iron; also six gas-fired crucible pot furnaces, two high-temperature electric pot furnaces, one tank-type gas-fired furnace, and a rotary furnace of the ordinary commercial type for smelting enamels. The equipment for dipping and spraying is modern and extensive. The enamels are fired in four electric furnaces of the chromel resistance type, all controlled by automatic recording control pyrometers. The largest furnace has a chamber $9 \times 10 \times 24$ inches. The testing equipment includes a swinging impact machine, a Lindemann-Danielson bonding test machine, binocular and ultrapac microscopes, and other miscellaneous laboratory apparatus. Spectrophotometer and X-ray equipment, and a specially designed machine for obtaining the tensile strengths of enamels are also available.

Kiln Laboratory.—The kiln laboratory, 42×100 feet in size, houses kilns and furnaces of various sizes and types used for both class work and research. The larger kilns include both oil- and coal-fired kilns ranging from one to three cubic yards capacity. Temperatures up to 2600° F. can be obtained. Several smaller kilns are used for firing individual experiments, and one of these is constructed for especially close regulation of heat distribution for temperatures up to 2700° F. Equipment for the testing of refractories includes small gas-fired furnaces for high-temperature fusion tests, and a gas-fired furnace, capable of temperatures up to 3100° F., for testing of refractories under load. There is also one rotating furnace for testing the resistance of fire brick to coal ash and other slags. Indicating and recording pyrometers are installed in a separate room with compensat-

ing leads for both base metal and noble metal thermocouples to each kiln and furnace. A recording carbon dioxide meter of the electrical resistance type is available for determination of combustion conditions in the larger kilns.

Structural Clay Products Laboratory.—A part of the floor space in the kiln laboratory is utilized for machinery equipment. There is installed a brickmaking unit with pug mill, auger machine, and hand-operated cutter. A smaller auger machine for making tiles and bars, a small de-airing unit, a Simpson mixer, a 7 x 10-inch jaw crusher, five-foot dry and wet pans, a vibrating screen, a hand-power sagger press, a hand-power repress, a 50,000-pound capacity hydraulic press, smaller plunger presses, and a dryer complete the equipment of this laboratory.

Drying Laboratory.—Experiments on the drying of clay products and studies of the fundamental principles involved in drying are conducted in a drying cabinet with forced air circulation and automatic control of temperature and relative humidity.

Microscopy Laboratory.—The petrographic microscope equipment includes instruments with complete accessories for research and others for student instruction, three binocular microscopes, dark field paraboloid condenser, cardioid condenser, camera for taking photomicrographs with lens attachments for macrophotography, and thin-section cutting apparatus. There is a large collection of minerals, ceramic raw materials, ceramic wares including refractories illustrating the effects of service in glass melting and other furnace operations, and specimens of faults found in defective glass. The equipment is sufficiently extensive and so chosen as to permit the study of particles of all sizes falling within the whole range of optical visibility.

Research Laboratories.—Research is an important function of the department, and excellent equipment is provided for this type of work in several laboratories separate and distinct from all others. For investigations which must be conducted at high temperatures, a variety of furnaces capable of close temperature regulation, and some with atmospheric control, are available. In addition to the above equipment, there are available a super centrifuge, a colloid mill, and Fizeau-Pulfrich interferometers.

Museum.—Most of the departmental museum specimens exemplify engineering phases of ceramics. In addition, a collection of about two hundred objects has been acquired through purchase and gifts, which affords a view of the scope of ceramic art. These include representative pieces from American and foreign potteries.

Ceramics Library.—There is a departmental library of about one thousand volumes, restricted to ceramics and the parts of physical and chemical sciences which are important in its study. Additional sources of ceramic information are present in the thirty-six periodicals and journals for which the department subscribes.

Civil Engineering Laboratories and Equipment

The laboratories of the Department of Civil Engineering are housed in the Talbot Laboratory and in two separate buildings, the Sewage Treatment Laboratory and the Surveying Building, and include the bituminous laboratory, the non-bituminous laboratories, the soils laboratory, the

sanitary laboratory, the cement and concrete laboratory, and the structural laboratory (large crane bay). Most of the laboratories are used for both instruction and research.

Bituminous Laboratory.—This laboratory contains the usual facilities for the testing and study of asphalts, tars, and similar materials used in building construction, road building, and other engineering work.

Non-Bituminous Laboratories.—These laboratories contain the usual installation of rattlers, abrasion and impact machines, ovens, and other equipment needed for the testing and study of paving brick, building stone, concrete aggregates, and stone and gravel used in road building.

Cement and Concrete Laboratory.—Modern equipment is available in this laboratory for making the standard tests on Portland and other cements, and also for the study of plain concrete. Storage bins, screens, scales, mixers, moist rooms, and a low-temperature unit provide for classroom work and a limited amount of research on the effect of materials, proportions, temperatures, and other factors governing the character and strength of concrete. (See description of the concrete research laboratory in the Department of Theoretical and Applied Mechanics.)

Sanitary Laboratory.—This laboratory is equipped for making the usual bacteriological and chemical analyses of water, and for the study of sewage. It is supplemented by the Sewage Treatment Laboratory.

Sewage Treatment Laboratory.—This is a complete, full-sized, experimental sewage-treatment plant available primarily for research in methods of sewage treatment and disposal.

Soils Laboratory.—This laboratory contains equipment necessary in the performance of (a) the routine tests for the classification of subgrade soils, and (b) tests for the physical characteristics of soils in foundations and embankments. A room in which a high relative humidity may be maintained is included in the facilities, which are being expanded in step with new developments in the field of soil mechanics.

Structural Research Laboratory.—The structural research laboratory has been designed and equipped to test large structural members and whole structures in steel or concrete as distinguished from tests to determine the physical properties of materials. Much of the equipment is special, being designed and built for tests of particular members or structures. Some outstanding installations of this kind include, the equipment used in the tests of multiple-span reinforced concrete arch bridges having an overall length of about 100 feet and a height of 35 feet; two 200,000-lb. fatigue testing machines for subjecting joints in structural members to repeated and reversed loads, and tension machines for subjecting structural members to high-speed loading.

The main laboratory, which is shared with the Department of Theoretical and Applied Mechanics, is 40 feet wide by 147 feet long and occupies the central portion of the building to its full height. It is served by a 10-ton crane 50 feet above the floor. This laboratory, in addition to having a heavily reinforced floor for testing structures requiring special apparatus, contains an Emery-Tatnall testing machine of 3,000,000-lb. capacity, a 600,000-lb. Riehle testing machine, and a number of other relatively large standard machines. There is a second laboratory, also shared with the



A CLASS IN FRESHMAN GENERAL ENGINEERING DRAWING



A CLASS IN SENIOR STRUCTURAL DESIGN

Department of Theoretical and Applied Mechanics, which is 24 feet wide by 147 feet long by two stories high, served by a crane 16 feet above the floor.

Surveying Laboratory.—The equipment and facilities for working in surveying are housed in a separate building on the south campus, near the practice fields. Numerous transits, levels, plane tables, tapes, and smaller instruments are available for regular surveying practice. Several instruments of high precision are provided for advanced work. There is a sufficient number of instruments with all supplemental equipment for approximately 30 transit parties, 30 level parties, and 10 plane-table parties at the same time.

Drafting and Design Rooms.—The department has at its disposal eight large drafting rooms for junior and senior students in design work. Each student is thereby able to have his own desk for work at any time as he would in a commercial drafting office.

Electrical Engineering Laboratories and Equipment

The laboratory facilities of the Department of Electrical Engineering include the dynamo laboratories, the calibration laboratory, the high-voltage laboratory, the illumination laboratory, the radio laboratory, the electronics laboratory, the communication laboratory, the meter laboratory, and the research laboratories.

Dynamo Laboratories.—The two dynamo laboratories contain a large assortment of electric generators, motors, and transformers, together with auxiliary equipment and special devices used by junior and senior students in their experiments. Equipment of these two laboratories permits tests covering a wide range of current, voltage, and frequency.

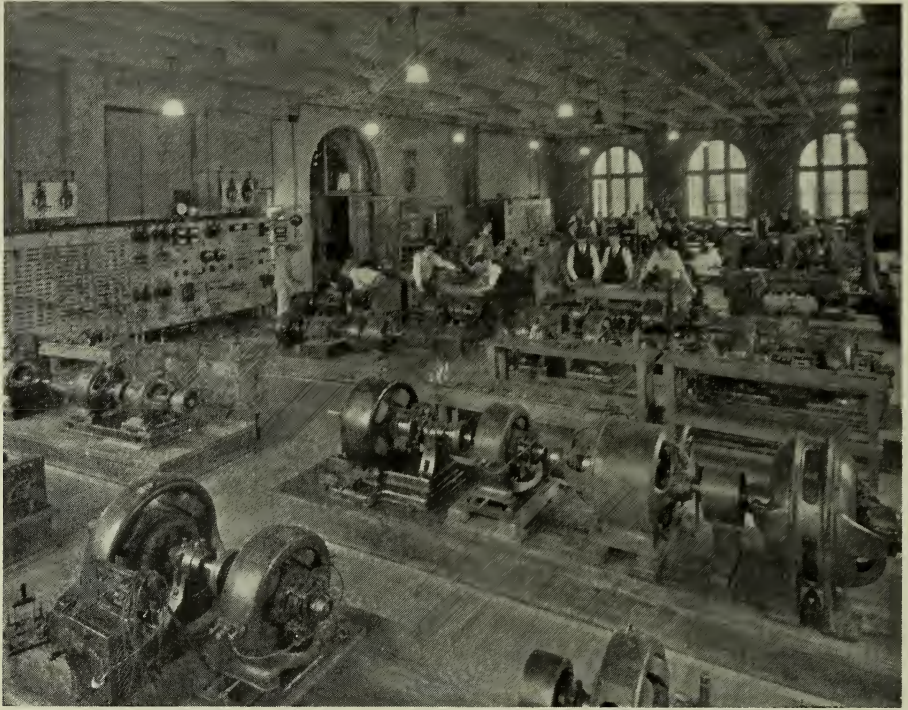
Calibration Laboratory.—This laboratory contains standard cells, resistances, potentiometers, and other devices necessary for checking the accuracy of the various types of electrical instruments used in the experimental work of the department. The meters used in the various laboratories are regularly checked in the calibration laboratory.

High-Voltage Laboratory.—Located in a building which affords ample space necessary for the safe housing of high-voltage equipment, this laboratory is equipped for the making of tests up to 300,000 volts alternating potential and 100,000 volts continuous potential.

Illumination and Photometry Laboratory.—Photometric dark rooms and a lecture room with seating capacity of about 100 persons are parts of the illumination laboratory. The equipment includes an excellent assortment of special devices to illustrate the principles and practices of lighting.

Radio Laboratory.—Besides equipment for instruction in the principles of radio communication, the radio laboratory is provided with a short-wave transmission set, television transmitting and receiving equipment, radio-frequency standards, and full equipment for making radio-frequency measurements and tests.

Electronics Laboratory.—This laboratory occupies three rooms on the second floor of the Electrical Engineering Building, and is well equipped for



ONE OF THE ELECTRICAL MACHINE LABORATORIES

experimental work in the highly important and rapidly developing field of electronics.

Communication Laboratory.—This laboratory contains a long artificial transmission line and many pieces of special equipment used by students in their experimental studies of the telephone and telegraph circuits.

Meter Laboratory.—The equipment of the meter laboratory includes standards and special apparatus for studying the performance of protective relays, watt-hour meters, and other devices used in recording electrical energy.

Research Laboratories.—These laboratories occupy several rooms which are used in connection with the Engineering Experiment Station activities of the department and nine smaller individual research rooms used by graduate students and members of the department staff engaged in special investigations. Many pieces of equipment such as electric oscillographs, harmonic analyzers, high-frequency oscillators, etc., are available for research. There is a well-equipped shop for the construction and repair of the department apparatus, and also a room supplied with a full assortment of glass-blowing devices for the use of those who need to construct glass apparatus in their research.

General Engineering Drawing Laboratories and Equipment

The facilities of this department are modern and complete. The department has at its disposal drafting rooms and model equipment sufficient to accommodate eight hundred students. Its facilities for the reproduction of drawings and printed material consist of a photostat, a large-size electric-driven continuous blueprinting machine with electric dryer, an electric arc machine, Directo and Ozalid developing machines, and a standard Colts Armory printing press with type and accessories. The pressroom houses several thousand zinc etchings on permanent mountings for problem use in courses in drawing and descriptive geometry. All specifications and instruction sheets for student work are printed by means of this equipment. The department owns a complete collection of modern drafting equipment for both display and classroom use.

Mechanical Engineering Laboratories and Equipment

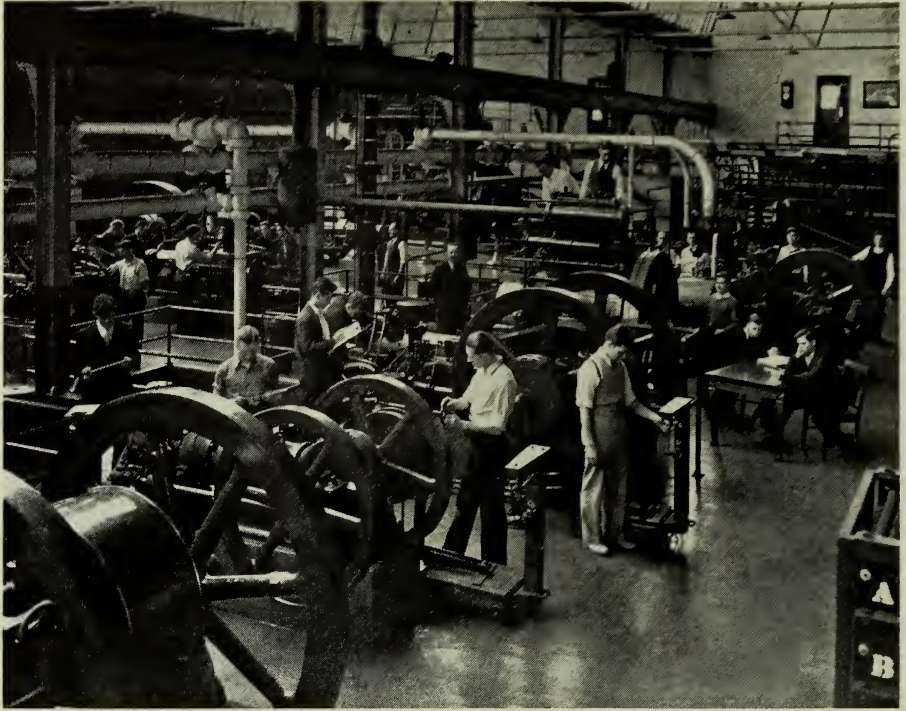
The laboratory facilities of the Department of Mechanical Engineering, not including the design and computation facilities, consist of two main units immediately contiguous to the steam and electric power-generating plants of the University. One is the Mechanical Engineering Laboratory, the other the Shop Laboratories.

Mechanical Engineering Laboratory.—This laboratory houses the steam power, internal-combustion engine, fuel-testing, heating, ventilating, air-conditioning, and refrigerating equipment used in carrying on the testing and experimental work required in the mechanical engineering curriculum. Ample provision is also made for graduate and research work. The principal prime movers installed in the laboratory consist of five steam engines, one steam turbine, two oil engines, two gas engines, and five automobile motors, including one multi-cylinder direct injection oil engine. All of these prime movers are equipped with complete auxiliary testing facilities. The pumping machinery consists of several direct-acting simplex steam pumps, a compound direct-acting duplex steam pump, a number of injectors, and several motor-driven centrifugal pumps.

For problems pertaining to air compression and refrigeration, the following equipment is available: a two-stage air compressor having compound steam cylinders, two motor driven air compressors, a two-stage, high pressure unit and a single stage unit, a steam driven ammonia compressor, a motor driven ammonia compressor, an absorption machine, and a household refrigerator demonstrating model.

The equipment available for instruction and research in the heating, ventilating, and air-conditioning field includes a steam-radiator testing booth, an experimental all-year air conditioning unit, a number of fans, a heating boiler equipped with stoker, a warm-air furnace testing plant with the necessary auxiliaries, and a special low-temperature testing plant.

In addition to the equipment enumerated above and the usual small instruments required in testing work, the Mechanical Engineering Laboratory has a number of dynamometers and brakes, flow meters, fuels and gas calorimeters, coal-analyzing equipment, clutch and belt testing apparatus,



A SECTION OF THE MECHANICAL ENGINEERING LABORATORY

equipment for testing brakes and speed reducers of various types, and a motor-generator set.

The Shop Laboratories.—In this building are the pattern laboratory, foundry laboratory, machine laboratory, and heat treatment laboratory. All of these laboratories are concerned with the preparation of parts used in the production of machinery. Their facilities are available for research and graduate work as well as undergraduate work.

The pattern laboratory is equipped with the necessary machines and tools for the designing and making of metal and wood patterns for quantity production. The equipment available for instructional work in the foundry laboratory includes complete apparatus for the testing and grading of foundry sands, various types of molding machines, a cupola for the melting of gray iron, an electric and gas furnace for the melting of non-ferrous metals, core ovens, and all machinery necessary for cleaning castings.

The machine laboratory equipment consists of lathes, milling and gear-cutting machines, shapers, planer, precision and tool grinders, drilling and boring machines, tool dynamometers (for measuring forces exerted upon lathe tools and drills when cutting metal), and apparatus for testing lubricating oils. In addition, the machine laboratory has a complete set of special tools, jigs, and fixtures for demonstrating the methods used in a modern production shop.



THE MACHINE LABORATORY

In the heat treatment laboratory the equipment includes gas and electric furnaces, recording pyrometers, a tensile-testing machine, hardness-testing machines, polishing and etching apparatus, metallurgical camera, and microscopes for the study of the physical properties of metals.

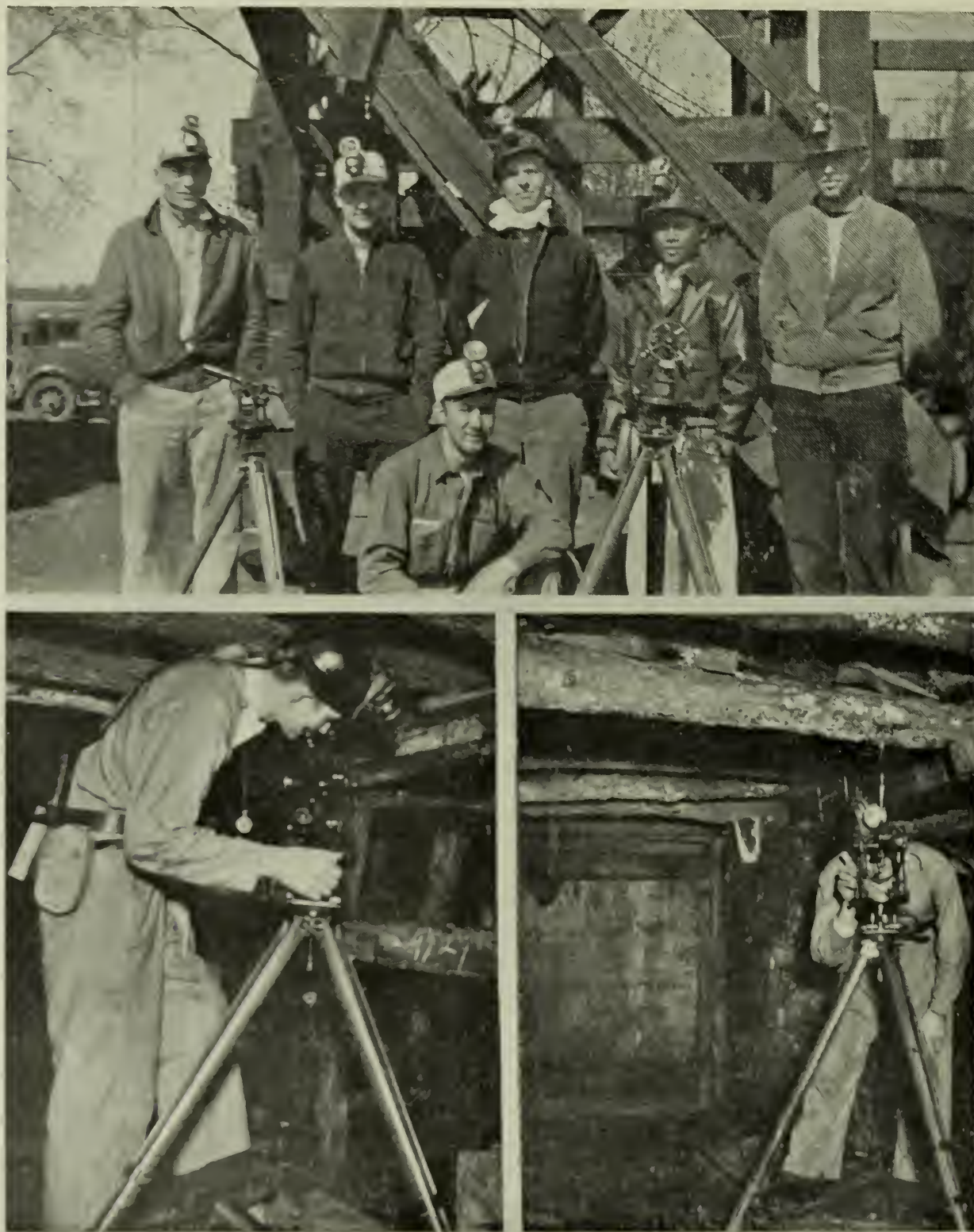
The welding laboratory is equipped with gas and arc welding apparatus, microscopes, polishing and etching equipment, and testing machines.

Mining and Metallurgical Engineering Laboratories and Equipment

The laboratories housed in the building called the Mining Laboratory include the sampling and grinding laboratory, the chemical and physical laboratory, the coal preparation and ore dressing laboratory, the ventilation laboratory, and the drilling and blasting laboratory.

Sampling and Grinding Laboratory.—Complete field and laboratory equipment is available for sampling and for the reduction of samples. The grinding room is equipped with a jaw crusher, coal grinders and pulverizers, disc-type pulverizing mills, pebble mills, testing sieves and sieving-test apparatus, mechanically-driven agate mortar, sample mixer, etc.

Chemical and Physical Laboratory.—This section of the laboratory is used for control of various coal-cleaning, coal-utilization, ore-dressing, and metallurgical tests. Chemical equipment is available for all types of analytical work, including complete equipment for the proximate or ultimate analysis of coal, sulphur in coal, fusibility of ash, and the calorific value of coal. Special apparatus includes a gas calorimeter, sulphur turbidimeter, colorimetric pH comparator, combustion trains, and specific gravity apparatus for solids, liquids, and gases. A petrographic microscope and an ore-



CLASS WORK IN MINE SURVEYING

dressing microscope are available for studying special coal and ore problems. A well-equipped balance room adjoins this laboratory.

Coal Preparation and Ore Dressing Laboratory.—Approximately half of the equipment of the main laboratory is special apparatus for the testing of coal. Equipment is available for float and sink tests for any size samples and for any size of coal. The friability, or drop test, apparatus is also located in this laboratory.

Apparatus or machinery of special application to coal preparation prob-



A SECTION OF THE METALLOGRAPHY LABORATORY

lems includes coal crushers and pulverizers, shaker and vibrating screens, wet concentrating tables, air table, jigs, sand-flotation, froth flotation, a centrifugal drier, and filters. A briquetting press is available for the making of coal briquets.

In addition, equipment that has a special application to ore-dressing and hydrometallurgical problems is as follows: coarse rock breakers, rolls, pebble, ball, and rod mills, hydraulic and mechanical classifiers, stamp mill with amalgamation plates, sand and slime leaching equipment for gold or other metallic ores, magnetic separator, electrostatic separator, and a large drying oven.

Ventilation Laboratory.—A collection of the various kinds of miner's lights, dating from the primitive fire wheel to the modern types of flame safety lamps and approved electric cap lamps, is one of the most complete in the country. A photometer, gas-analysis apparatus, and Oldham lamp-testing machine, as well as gas detectors, are available for research and instruction purposes. In addition, mine-ventilation models, fans, and a duct system in which small-scale shaft and timbering conditions may be simulated and tested, comprise a very important part of the ventilation laboratory. Miscellaneous equipment consists of anemometers, sling psychrometers, katathermometers, Wahlen and Ellison gages, etc.

Drilling and Blasting Laboratory.—Representative drilling machinery and accessories consist of hand and electric augers, rock drills of various types, a portable diamond drill, a gas-fired heating furnace for drill steel, a compressed-air drill-sharpener, etc. Dummy cartridges, squibs, fuses, electric detonators, tamping tools, blasting machines, circuit testers, shot-firing equipment, and a demonstration model for studying the charging of drill holes are to be found in this laboratory.



STUDENTS USING GAS AND ELECTRIC FURNACES IN METALLURGICAL LABORATORY



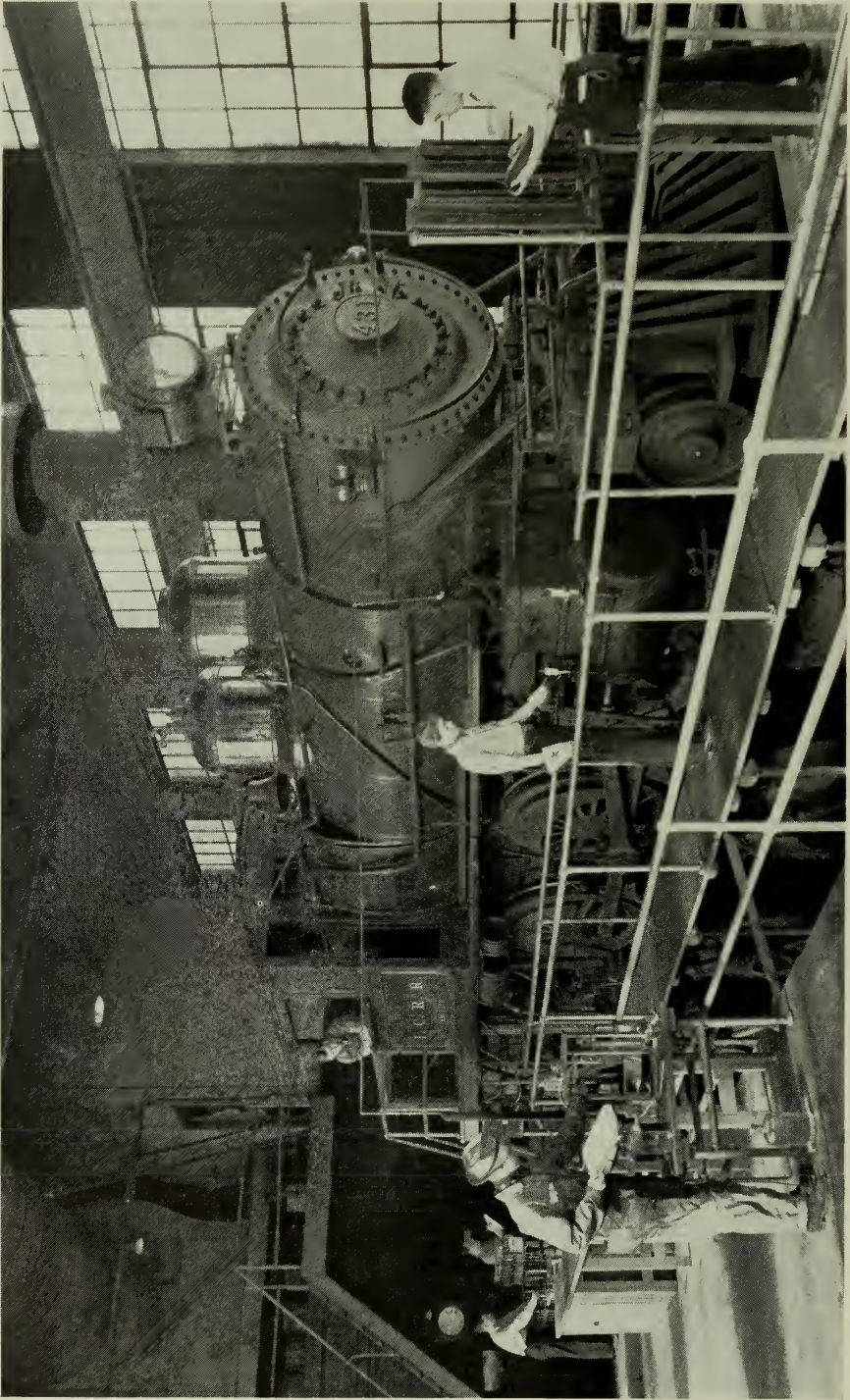
A LECTURE-DEMONSTRATION CLASS IN GENERAL PHYSICS

The laboratories housed in the building called the Metallurgical Laboratory include the metallographic laboratory, the heat treatment laboratory, and the electrometallurgical laboratory. This is a fireproof structure, erected in 1936 as a wing to the Mining Laboratory.

Metallographic Laboratory.—This laboratory includes a rough-grinding room with etching hood, separated from the main metallographic laboratory by a glass partition. The equipment of the latter includes ten metallographic microscopes (Leitz and Bausch & Lomb), large work tables, and unit polishing machines. Adjoining are the camera room, including a Leitz Micro-Metallograph and macro-camera, and large developing and printing rooms. All the rooms in the Metallographic Laboratory are ventilated with tempered air.

Heat Treatment Laboratory.—The furnaces are all in one large, well-lighted laboratory. Large, medium, and small gas and electric furnaces, some with time-clock and automatic control, are used for heat treatment, and large gas muffles for assaying. Adequate pyrometric equipment is at hand, consisting of base and noble metal thermocouples, potentiometers, millivoltmeters, and optical and radiation pyrometers. One side of this room is equipped for physical testing with a Riehle universal 40,000-lb. testing machine, a Brinell and a Rockwell hardness-testing machine. The facilities of the Materials Testing Laboratory (see page 37) are used for large specimens or for special testing. A large high-speed cut-off machine is also housed here.

Electrometallurgical Laboratory.—For small-scale experimental work there is a large laboratory equipped with tables, hood, voltmeters, ammeters, and accessory electrical equipment, and supplied with both direct- and



MAKING READY FOR A TEST RUN ON A LIGHT FREIGHT LOCOMOTIVE

alternating-current. Adjoining it is another laboratory containing booths for electric welding, and a Lincoln arc-welder. Additional equipment, such as arc, resistance, and high-frequency furnaces, is being added to this laboratory.

Mention should also be made of special equipment available for research work such as a Zeiss Neophot, a Vickers hardness-testing machine, and a dilatometer.

Physics Laboratories and Equipment

The laboratories of the Physics Department supply facilities for instruction and investigation in many branches. They are especially well equipped for investigations in spectroscopy, high vacua, acoustics, magnetism, electrical measurements, and optics. Gas, direct and alternating current at several voltages, distilled water, compressed air, vacuum, and liquid air are freely available. There are two workshops, one for the mechanics of the department and one for instructors and advanced students. There is a glassblowing shop in charge of a glassblower. An excellent working library of periodicals and books of special use in connection with the courses in physics is maintained on the second floor of the Physics Laboratory.

Railway Engineering Laboratories and Equipment

Three laboratories house the equipment in Railway Engineering, namely, the Locomotive Testing Laboratory, the Brake Shoe Testing Laboratory, and the Railway Electric Laboratory. In addition, there is a dynamometer car measuring draw-bar pulls up to 90,000 pounds, a fully equipped electric test car, and a drop testing machine.

Locomotive Testing Laboratory.—For purposes of instruction, a light freight locomotive is permanently available in this laboratory. It is of the mogul type with simple cylinders using saturated steam. The testing equipment in this laboratory is extensive enough and of such size to permit tests being run on modern locomotives, a condition that prevails in only one other place in this country.

Brake Shoe Testing Laboratory.—This laboratory houses a brake shoe testing machine and accessories capable of exerting a shoe pressure of 22,000 pounds and operating at speeds up to 100 miles per hour. It is fully equipped for measuring and recording the tangential pull of the brake shoe.

Railway Electric Laboratory.—There is installed in this laboratory equipment for simulating the starting conditions of an 8-ton standard Birney safety car; a three-phase induction motor connected to a 50-kw, 600-volt, direct-current generator; a 50-kw, 600-volt, direct-current mercury-arc rectifier, a 15-kw, 25-cycle, 300-volt alternating-current generator; and other equipment necessary for instruction and research work in electric car transportation.

Theoretical and Applied Mechanics Laboratories and Equipment

The laboratories of the Department of Theoretical and Applied Mechanics are: the large crane bay, two material testing laboratories, the fatigue of metals laboratory, the hydraulics laboratory, the concrete research laboratory, several smaller laboratories, and a large machine shop. These



STUDENTS OPERATING THE ELECTRIC RAILWAY TEST CAR

individual laboratories are housed in a portion of the Arthur Newell Talbot Laboratory, which is a large four-story building. The plan of the building is in the form of an **H** with two wings 187 by 50 feet and a stem of 110 by 92 feet. A portion of this building is used for the laboratories of the Department of Civil Engineering, and some of the larger testing machines are used jointly by the two departments.

Large Crane Bay.—This room, 40 feet wide by 147 feet long, occupies the central portion of the building to its full height. It is served by a

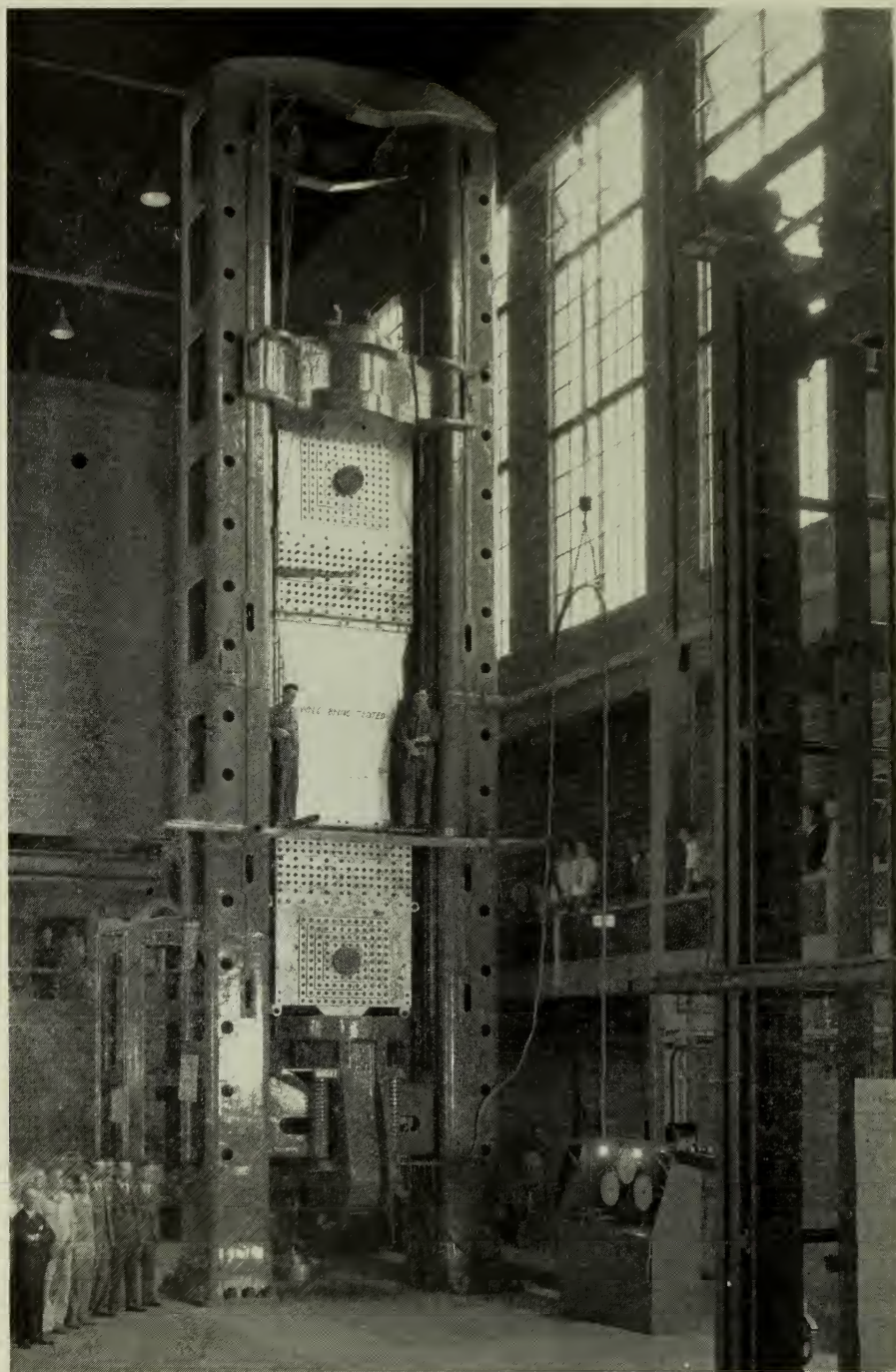


ONE OF THE APPLIED MECHANICS LABORATORIES

10-ton crane 50 feet above the floor. This is the laboratory in which large structural members are tested. The crane bay contains an Emery-Tatnall testing machine of 3,000,000-pound capacity, a 600,000-pound Riehle testing machine, and a number of other relatively large machines. These machines are also a part of the structural research laboratory of the Department of Civil Engineering.

Materials Testing Laboratories.—These laboratories occupy the second floor of the west wing of the building and they are used mainly for the instruction of students. They contain nine testing machines with capacities of from 50,000 to 200,000 pounds, equipped with individual motor drives. In addition there are a considerable number of smaller hand-operated machines and various types of machines for making special tests, such as hardness, impact, etc.

Fatigue of Metals Laboratory.—This laboratory occupies the third story of the northwest wing of the building and is devoted to the study of the behavior of metals under repeated loading. There are twenty-four repeated-stress testing machines of various sizes and types. Many of these machines



TESTING A WELDED JOINT IN THE 3,000,000-POUND TESTING MACHINE

were designed by the staff of the laboratory and constructed in the laboratory shop.

Concrete Research Laboratory.—This laboratory occupies the basement in the southwest wing of the building. It has storage space for concrete materials and contains concrete mixers, a concrete saw, a core drill, and other equipment used in the study of plain and reinforced concrete. Large moist rooms with temperature control provide standard curing conditions for test pieces. The laboratory is served by a six-ton crane and is equipped with various types of machines for the testing of concrete and reinforced concrete.

Hydraulics Laboratory.—The hydraulics laboratory occupies the basement and first floor of the west wing. Water is supplied to the laboratory from a standpipe six feet in diameter and sixty feet high, located in one corner of the laboratory. Water is pumped into the standpipe from a sump in the basement by centrifugal pumps. The main upper floor of the hydraulics laboratory contains weirs, orifice tanks, meter-testing equipment, venturi meters, centrifugal pumps, a hydraulic ram, turbines, etc., for use in student experiments and in investigating engineering problems in hydraulics.

Miscellaneous Laboratories.—There are several smaller laboratories equipped for special work, such as laboratories for photographic work, metallographic investigations, cement investigations, and special tests in connection with investigations in cooperation with industries.

Machine Shop.—A large machine shop is located on the top floor of the southwest wing. This shop is well equipped for making specimens and apparatus for student use and for the construction of many types of research apparatus required in the investigations that are carried on in the laboratories.

Admission

ADMISSION to the College of Engineering is contingent on admission to the University of Illinois under the regulations administered by the Registrar of the University. The credits required for admission to the undergraduate departments may be secured in three ways: (1) by *certificate* from an accredited high school or other secondary school; (2) by *examination*; and (3) by *transfer* from another university or college of recognized standing. The following is a condensed statement of the conditions of admission as they affect students entering the College of Engineering. The Registrar should be consulted concerning all questions of detail arising in any particular case.

Official credentials should be sent directly from each institution previously attended to the Registrar at Urbana soon after the close of the school year in June, and on receipt of these, the Registrar will communicate with the applicant regarding his admission. If the credentials are not received until the week before the opening of the University, it may not be possible for the Registrar to notify the applicant of his status prior to his arrival on the campus. The University will not issue a permit to enter except on the basis of official detailed credentials filed in advance which meet the requirements for admission. Freshmen are required to be on the campus for the freshman week program preceding registration in September.

Applicants for admission who come from foreign countries must bring complete official credentials. Certificates from Oriental and Slavic countries must be accompanied by certified translations.

Qualified applicants are admitted at the beginning of either the first or the second semester. Applicants for admission to the College of Engineering will find it of some advantage to enter at the beginning of the first semester rather than the second.

Physical Examinations

All students, except those entering only for summer sessions, who have not previously taken a physical examination at the University, must take such an examination. Before registration, a new student must secure an appointment with the University Health Service for his physical examination. The examination is given by the University at the time of appointment without cost to the student. If the student fails to take the examination at the appointed time and does not present an excuse from the Registrar, a fee of \$5.00 is charged to provide for a special examination, or he will be required to be examined at his own expense outside the University in a manner meeting the requirements of the Health Service.

General Requirements for Admission to the University

Age.—An applicant must be at least sixteen years of age. The dean of the college concerned, however, may admit on petition a student fifteen years of age who meets all other requirements for admission and who is to reside, while attending the University, with his parents or guardian, or with someone selected by them.

High School Graduation.—To be admitted by certificate, an applicant must be a graduate of an accredited secondary school. If the school is in Illinois, it must be accredited by the University of Illinois; if located elsewhere, its rating must be equivalent to accreditation by the University of Illinois. Conditions under which non-graduates may be admitted are given below.

High School Scholarship.—An applicant for admission to the University whose rank in scholarship is in the upper three-quarters of his graduating class and who meets the requirements as stated below is admitted by certificate to full freshman standing. Furthermore, the Registrar is authorized to admit, without adhering to the usual requirements as they pertain to majors and minors, an applicant whose rank in scholarship is in the upper fifty per cent of his graduating class. Such a student, however, must present those specific high school courses that are prerequisite to courses in the curriculum which he desires to follow in the University.

A graduate of an accredited high school whose rank in scholarship is in the lowest quarter of his graduating class and who meets the requirements as stated below is admitted by certificate to probationary status and, in connection with his first registration in the University, is required to take such tests as may be prescribed by the Personnel Bureau. Such a student, immediately upon registration, is placed under the special supervision of the dean of the college or the director of the school in which he is enrolled. He may be required by the dean or director to carry a reduced program of work or a program especially arranged to meet his needs.

The student's rank is to be based on work completed in grades nine, ten, eleven, and twelve in the case of four-year high schools and on work completed in grades ten, eleven, and twelve in the case of three-year senior high schools.

Fifteen Units Required.—Fifteen units of acceptable secondary school work are required, including the following:

I. Two majors and one minor, selected from Groups 1-5 below. One of the majors must be English. (See definitions of *Unit*, *Major*, and *Minor* below.)

II. A total of at least nine units from the fields of English, foreign language, mathematics, science, and social studies, including preparation amounting to a major or minor sequence in at least three different fields. (See Groups 1-5 below.)

III. All subjects prescribed for the curriculum which the applicant desires to enter. (See paragraph on *special* requirements below.)

IV. The six remaining units necessary for admission may be selected from any of the high school subjects which are accepted by an accredited school toward its diploma and which meet the standards for accrediting as defined by the University of Illinois. Fractional credits of the value of less than one-half unit will not be accepted. Not less than one unit of work will be accepted in a foreign language, elementary algebra, plane geometry, physics, chemistry, or biology.

The University realizes the obligation of the high school to meet fully the needs and interests of all its pupils. It, therefore, believes that high schools should offer courses in such fields as agriculture, art, commerce, home economics, industrial arts, music. Furthermore, by accepting them for admission, it recognizes that they contribute to satisfactory preparation for college work.

Definitions

Unit.—A *unit course of study* in the secondary school is a course covering an academic year and including not less than the equivalent of 120 sixty-minute hours

of classroom work. Two hours of work requiring little or no preparation outside the class are considered as equivalent to one hour of prepared classroom work.

Major.—A *major* consists of three unit courses in one field. (See special requirements for a major in each of the various fields as stated below.)

Minor.—A *minor* consists of two unit courses in one field. (See special requirements for a minor in each of the various fields as stated below.)

Majors and Minors

The required majors and minors defined above may be selected from the following five groups:

(1) *English.*—(In all cases one major must be in English.) Only courses in history and appreciation of literature, composition (including oral composition when given as a part of a basic English course), and grammar will count toward a major.

(2) *Foreign Language.*—Three units in one language constitute a major. Two units in one language constitute a minor.

(3) *Mathematics.*—Only courses in algebra, plane geometry, solid and spherical geometry, and trigonometry will be accepted toward a major or minor in this subject. (General mathematics may be accepted in lieu of algebra and geometry in cases where the content of the course is essentially the same as that ordinarily included in algebra and geometry.)

(4) *Science.*—(Including physics; chemistry; biology, or botany and zoology; general science, or physiology and physiography; astronomy; and geology.) The three units required for a major must include at least a total of two units chosen from one or more of the following subjects: physics, chemistry, botany, and zoology. Biology may be offered in place of botany and zoology. The two units required for a minor must include at least one unit from the above subjects.

(5) *Social Studies.*—(Including history, civics, economics, commercial or economic geography, and sociology.) The three units required for a major must include at least two units in history. The two units required for a minor must include at least one unit in history.

Special Requirements and Recommendations

The *special* minimum requirements for admission to the various curricula of the College of Engineering are: English, three units; algebra, one and one-half units; plane geometry, one unit; and solid geometry, one-half unit. (A student may enter the College of Engineering with a deficiency in solid geometry or advanced algebra, or both, provided he meets all other entrance requirements. His deficiency in mathematics must be removed during his first year of residence.)

As a further aid to the high school student who plans to enter any one of the curricula of the College of Engineering it is recommended that he present, in addition to the *special* minimum requirements listed above, at least a *minor* in the following subjects, stated in the order of preference: (1) French or German or Latin; (2) science; (3) social studies; and (4) industrial arts.

Graduates of Unaccredited Secondary Schools

Graduates of unaccredited secondary schools which offer four years of instruction are admitted by examination. The Registrar, however, is authorized to admit a student who is a graduate of such an unaccredited secondary school and whose general scholarship rank is in the upper twenty-five per cent of his graduating class, subject to his passing at the University in advance of admission: (1) a test in English composition and rhetoric; and (2) such other examinations and tests in high school subjects as may be necessary to complete the University entrance requirements and the special requirements of the chosen curriculum.

Students from Accredited Secondary Schools Who Are Not Graduates

An applicant who has attended, but who has not been graduated from, an accredited school, must pass entrance examinations in English composition and four units in additional subjects to be designated by the University authorities. The remaining units required for admission may also be made in entrance examinations or may be offered by certificate from an accredited school.

Graduates of Three-Year Senior High Schools

In the case of graduates of a school organized as a three-year senior high school, including grades ten, eleven, and twelve, at least twelve units must have been taken in the senior high school. Two majors and one minor, or four minors, must be from the fields of English, foreign language, mathematics, science, and social studies. Either a major or a minor must be from the field of English. One unit of a foreign language and one unit of mathematics may be accepted from work completed in the ninth grade as a part of the majors and minors, provided at least seven units of senior high school work have been completed in subjects included in the above enumerated fields. The remaining five units may be selected from any of the senior high school subjects which are accepted by an accredited high school toward its diploma and which meet the standards for accrediting as defined by the University. The transcript of credits certified by the senior high school must show any credit in mathematics or foreign language accepted from the ninth grade if these subjects have been continued in the senior high school. Fractional credits of the value of less than one-half unit will not be accepted. Not less than one unit of work will be accepted in a foreign language, elementary algebra, plane geometry, physics, chemistry, and biology.

Unclassified Students

Persons over twenty-one years of age may be admitted as unclassified students (not candidates for a degree) in the undergraduate colleges at Urbana, provided they secure the recommendation of the instructor whose work they wish to take and the approval of the dean of the college. They must give evidence that they possess the requisite information and ability to pursue profitably, as unclassified students, their chosen subjects, and they must meet the special requirements of the college as stated above.

An unclassified student is not matriculated and must pay a fee of \$7.50 a semester in addition to the regular incidental fee.

No one may enroll as an unclassified student in any school or college of the University *for more than two years*, except by special permission, application for which must be made through the dean of the college.

Admission to Correspondence Courses

Correspondence courses are open to any applicants who can meet the University entrance requirements and also to persons eighteen or more years of age whose applications are approved by the Director of University Extension. For further information address the Director, 354 Administration Building (West), Urbana.

Admission to the Graduate School

Admission to the Graduate School may be granted to graduates of institutions whose requirements for the bachelor's degree are substantially equivalent to those of the University of Illinois. Admission may be to full graduate standing, to graduate standing, with certain deficiencies to be removed, or, to special status without reference to a degree. Admission to the Graduate School does not, however, imply admission to candidacy for a degree, and gives no right or claim to be so admitted. A mere accumulation of "credits" or "grades" is not sufficient. Application blanks for admission may be secured from the Registrar. Every applicant must submit with his application for admission an official transcript of his college record. Further information is given in the *Announcement of the Graduate School*, copies of which may be obtained by addressing the Dean of the Graduate School, 109 Administration Building, Urbana, Illinois.

Curricula and Degrees in Engineering

EACH of the following ten curricula, leading to the degree of Bachelor of Science, may ordinarily be completed in a period of four years. The degree of Master of Science may be earned in one additional year. The professional degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, etc., follow the B.S. or M.S. degree in consequence of professional practice over a period of not less than four years and the presentation of a thesis based on some engineering work of an original character. The significance and importance of these advanced degrees to the engineer of the future are discussed in the section on graduate work (page 78).

Elective courses are specified in each curriculum under descriptive terms as follows: *non-technical electives* which, with few exceptions, are restricted to courses above freshman grade outside the College of Engineering; *technical electives* which include all courses in the College of Engineering not required in the student's curriculum, excepting Engineering 10, 20, 39, 40, 41, 92, and all elementary work in drawing (some courses in other colleges are considered *technical* for purposes of this requirement); *approved electives* which include both non-technical and technical electives as defined above; and *technical options* which include only stated technical courses within definite fields of knowledge related to the subject-matter of a particular curriculum. These latter electives are not options within a curriculum in the sense defined below, but merely restricted technical elective courses.

Most of the curricula of the College of Engineering provide the opportunity for concentration of the student's effort in the senior year along lines of his particular interest, within the broad field of his chosen curriculum. This is accomplished by *curriculum options*, which are groupings of subject-matter related to recognized fields of concentration in professional engineering practice. Examples are the highway, hydraulic, sanitary, structural, and railway options in the Civil Engineering curriculum. This arrangement secures the demonstrated advantages of the more flexible and completely elective system prevailing in some quarters, and it preserves the virtues of a prescribed curriculum for the guidance of students whose meager practical experience does not avail them much in rounding out their educational program. Senior theses further emphasize the field of concentration.

In any curriculum where a definite *language* requirement is specified, each year of high school credit in that language is considered the equivalent of one semester in the curricular requirement. When the language subject-matter requirement has been met in full in this way, the student may meet the credit-hour requirements by continuing the language in college or by offering other college credit instead. In all other curricula no less than one year's college work in one modern language (English, French, German, or Spanish) may be substituted for the approved elective to the extent of the hours specified in a particular curriculum, or it can be otherwise used as stated in special cases.

A description of the individual courses offered in each department of the College of Engineering is given in a following section. For a description

of courses offered in other colleges and schools of the University, some of which are included in the curricular requirements of engineering students, the reader is referred to the *Annual Register* of the University. (Requests for copies of the *Annual Register* should be addressed to the Registrar, Urbana, Illinois.) Names of departments and divisions are abbreviated in the listing of courses in the curricula, as follows:

Accy.....	Accountancy	Geol.....	Geology
Agr. Econ.....	Agricultural Economics	Math.....	Mathematics
Agr. Eng.....	Agricultural Engineering	M.E.....	Mechanical Engineering
Cer.E.....	Ceramic Engineering	Met.....	Metallurgy
Chem.....	Chemistry	Min.....	Mining Engineering
C.E.....	Civil Engineering	Phys.....	Physics
Econ.....	Economics	Pol.Sci.....	Political Science
E.E.....	Electrical Engineering	R.E.....	Railway Engineering
G.E.D.....	General Engineering Drawing	T.A.M....	Theoretical and Applied Mechanics

Common Program for Freshmen

Freshmen in the College of Engineering take this program unless otherwise specified in the curricula outlined on following pages.

First Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Chem. 2 or 3—Inorganic Chemistry..	3 or 4	Chem. 4—Metallic Elements.....	4
G.E.D. 1 or 4—Elements of Drawing..	4	G.E.D. 2—Descriptive Geometry....	4
Math. 2—Advanced Algebra.....	3	Math. 6a—Analytic Geometry.....	4
Math. 4 or 5—Trigonometry.....	2	Rhet. 2—Rhetoric and Composition..	3
Rhet. 1—Rhetoric and Composition..	3	Hygiene.....	2
Physical Education.....	$\frac{1}{2}$	Physical Education.....	$\frac{1}{2}$
Military Science (for men).....	1	Military Science (for men).....	1
Engineering Lecture.....	0	Engineering Lecture.....	0
<i>Total.....</i>	$16\frac{1}{2}$ or $17\frac{1}{2}$	<i>Total.....</i>	$18\frac{1}{2}$

Curriculum in Agricultural Engineering

For the Degree of Bachelor of Science in Agricultural Engineering

First Year

Common Program for Freshmen (above), except that Chem. 5 is substituted for Chem. 4.

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Agr.Eng. 2—Field and Power-Driven Machinery.....	3	Agr.Eng. 3—Gas Engines and Tractors	3
Bot. 5—Botany.....	3	Agronomy 25—Farm Crops.....	4
Math. 7—Differential Calculus.....	5	Math. 9—Integral Calculus.....	3
Phys. 1a—General Physics.....	4	Phys. 1b—General Physics.....	4
Phys. 3a—Physics Laboratory.....	1	Phys. 3b—Physics Laboratory.....	1
Physical Education.....	$\frac{1}{2}$	T.A.M. 1—Analyt. Mech. (Statics)..	2
Military Science (for men).....	1	Physical Education.....	$\frac{1}{2}$
<i>Total.....</i>	$17\frac{1}{2}$	Military Science (for men).....	1
		<i>Total.....</i>	$18\frac{1}{2}$

Third Year

MACHINERY AND POWER OPTION

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Econ. 2—Elements of Economics....	3	Agr. Econ. 20—Farm Management..	3
Geol. 44—Agricultural Geology.....	3	Agronomy 28—Soils.....	5
M.E. 31—Mechanics of Machinery....	5	M.E. 10—Thermodynamics.....	3
T.A.M. 2—Analyt. Mech. (Dynamics)	3	M.E. 40—Mech. Eng. Design.....	3
T.A.M. 3—Resistance of Materials...	3	M.E. 85—Pattern and Foundry Lab.	3
T.A.M. 63—Res. of Materials Lab....	1		
<i>Total</i>	18	<i>Total</i>	17

CONSTRUCTION AND DRAINAGE OPTION

C.E. 15—General Surveying.....	3	Agr. Econ. 20—Farm Management..	3
Econ. 2—Elements of Economics....	3	Agr.Eng. 12—Farm Utilities.....	3
C.E. 35—Plain Concrete.....	2	Agronomy 28—Soils.....	5
Geol. 44—Agricultural Geology.....	3	C.E. 61—Structural Stresses.....	4
T.A.M. 2—Analyt. Mech. (Dynamics)	3	T.A.M. 4—Hydraulics.....	2
T.A.M. 3—Resistance of Materials....	3	T.A.M. 64—Hydraulics Laboratory..	1
T.A.M. 63—Res. of Materials Lab....	1		
<i>Total</i>	18	<i>Total</i>	18

Fourth Year

MACHINERY AND POWER OPTION

Agr.Eng. 43—Farm Power.....	3	Agr.Eng. 44—Design of Agricultural Machinery.....	3
Agr.Eng. 99—Inspection Trip.....	0	Agr.Eng. 51—Special Problems.....	3
E.E. 11—D.C. and A.C. Circuits....	3	E.E. 12—D.C. and A.C. Apparatus..	3
E.E. 61—D.C. and A.C. Laboratory..	1	E.E. 62—D.C. and A.C. Laboratory..	1
M.E. 41—Mech. Eng. Design.....	4	M.E. 89—Heat Treatment of Metals	3
M.E. 87—Machine Tool Lab.....	3	Approved Elective.....	4
Approved Elective.....	3		
<i>Total</i>	17	<i>Total</i>	17

CONSTRUCTION AND DRAINAGE OPTION

Agr.Eng. 42—Hydraulics of Soil and Water Conservation.....	3	Agr.Eng. 51—Special Problems.....	3
Agr.Eng. 45—Advanced Farm Structures.....	3	C.E. 51—Drainage and Flood Control	3
Agr.Eng. 99—Inspection Trip.....	0	C.E. 87—Steel, Concrete, and Timber Design.....	4
C.E. 50—Hydrology.....	2	C.E. 90—Contracts and Specifications	2
C.E. 86—Steel, Concrete, and Timber Design.....	4	Approved Elective.....	4
E.E. 4—D.C. and A.C. Circuits and Machines.....	2		
E.E. 64—D.C. and A.C. Circuits and Machines Laboratory.....	1		
Approved Elective.....	2		
<i>Total</i>	17	<i>Total</i>	16

Curriculum in Ceramic Engineering

For the Degree of Bachelor of Science in Ceramic Engineering

First Year

Common Program for Freshmen (page 45), except that Chem. 6 is substituted for Chem. 4.

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Cer.E. 1—Ceramic Materials.....	3	Cer.E. 4—Ceramic Materials Lab....	3
Chem. 10—Qualitative Analysis.....	5	Chem. 23b—Quantitative Analysis... 4	
Math. 8a—Differential Calculus.....	3	Math. 8b—Integral Calculus.....	3
Phys. 1a—General Physics.....	4	Phys. 1b—General Physics.....	4
Phys. 3a—Physics Laboratory.....	1	Phys. 3b—Physics Laboratory.....	1
Physical Education.....	1½	T.A.M. 1—Analytical Mech. (Statics) 2	
Military Science (for men).....	1	Physical Education.....	1½
		Military Science (for men).....	1
<i>Total</i>	17½	<i>Total</i>	18½

Third Year

Cer.E. 5—Ceramic Bodies.....	5	Cer.E. 11—Drying Clay Products... 3	
Cer.E. 7—Structural Clay Products.. 3		Cer.E. 14—Glasses and Glazes..... 3	
Geol. 43—Engineering Geology..... 3		Cer.E. 21—Ceramic Pyrometry..... 1	
T.A.M. 2—Analyt. Mech. (Dynamics) 3		Chem. 40—Physical Chemistry..... 3	
T.A.M. 3—Resistance of Materials... 3		C.E. 16—Elementary Surveying..... 2	
T.A.M. 63—Resistance of Materials Laboratory.....	1	M.E. 62—Mech. Engineering Lab... 3	
<i>Total</i>	18	Approved Elective.....	3
		<i>Total</i>	18

ADMINISTRATION OPTION

B.O.O. 1—Industrial Organization and Management.....	3	B.O.O. 2—Marketing Organization and Operation.....	3
Cer.E. 5—Ceramic Bodies.....	5	Cer.E. 11—Drying Clay Products... 3	
Cer.E. 7—Structural Clay Products.. 3		Cer.E. 14—Glasses and Glazes..... 3	
Econ. 2—Elements of Economics... 3		Econ. 3—Money, Credit, and Banking 3	
T.A.M. 3—Resistance of Materials... 3		Rhet. 10—Business Letter Writing... 2	
T.A.M. 63—Resistance of Materials Laboratory.....	1	Approved Elective.....	3
<i>Total</i>	18	<i>Total</i>	17

Fourth Year

Cer.E. 22—Kilns and Burning.....	3	Cer.E. 20—Refractories.....	2
Cer.E. 23—Dryer and Kiln Design... 2		Cer.E. 24—Ceramic Engineering Design.....	3
Cer.E. 99—Inspection Trip.....	0	Cer.E. 28—Pyrochemical Problems.. 2	
C.E. 89—Structural Engineering.....	3	E.E. 5—Applications of Electrical Equipment.....	2
E.E. 4—D.C. and A.C. Circuits and Machines.....	2	E.E. 65—Electrical Equipment Laboratory.....	1
E.E. 64—D.C. and A.C. Circuits and Machines Laboratory.....	1	Approved Elective.....	3
Approved Elective.....	3	Technical Option ¹	3
Technical Option ¹	3	<i>Total</i>	16
<i>Total</i>	17		

¹Technical Options: Ceramic Engineering 8, 10, 16, 17, 18; Chemistry 33, 41; Electrical Engineering 90; Geology 20, 6; Physics 16; T.A.M. 41, 42; Mining 2; Metallurgy 1, 12.

ADMINISTRATION OPTION

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Cer.E. 21—Ceramic Pyrometry.....	1	Cer.E. 20—Refractories.....	2
Cer.E. 22—Kilns and Burning.....	3	Cer.E. 24—Ceramic Eng. Design....	3
Cer.E. 23—Dryer and Kiln Design....	2	Cer.E. 28—Pyrochemical Problems..	2
C.E. 89—Structural Engineering.....	3	Bus. Law 3—Law for Engineering	
B.O.O. 7—Salesmanship.....	2	Students; <i>or</i> Eng. 92—Law.....	3
<i>or</i>		Econ. 43—Personnel Administration	3
Accy. 12—Fundamentals of		Econ. 10—Corporation Finance; <i>or</i>	
Accounting.....	3	B.O.O. 22—Marketing Policies and	
B.O.O. 4—Management in Manufac-		Problems.....	3
turing.....	3	Approved Elective.....	2
<i>or</i>			
Eng. 39—Industrial Relations.....	3		
Approved Elective.....	2-3		
<i>Total</i>	17	<i>Total</i>	18

Curriculum in Ceramics

For the Degree of Bachelor of Science in Ceramics

First Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Chem. 2 <i>or</i> 3—Inorganic Chemistry... 3 <i>or</i> 4		Chem. 6—Inorganic Chemistry.....	5
Math. 2—College Algebra.....	3	Math. 6a—Analytic Geometry.....	4
Math. 4 <i>or</i> 5—Trigonometry.....	2	German <i>or</i> French.....	4
German <i>or</i> French.....	4	Rhet. 2—Rhetoric and Composition..	3
Rhet. 1—Rhetoric and Composition..	3	Hygiene.....	2
Physical Education.....	1½	Physical Education.....	1½
Military Science (for men).....	1	Military Science (for men).....	1
Engineering Lecture.....	0	Engineering Lecture.....	0
<i>Total</i>	16½ <i>or</i> 17½	<i>Total</i>	19½

Second Year

Cer.E. 1—Ceramic Materials.....	3	Cer.E. 4—Ceramic Materials Lab....	3
Chem. 10—Qualitative Analysis.....	5	Chem. 23b—Quantitative Analysis...	4
Math. 8a—Differential Calculus.....	3	Math. 8b—Integral Calculus.....	3
Phys. 1a—General Physics.....	4	Phys. 1b—General Physics.....	4
Phys. 3a—Physics Laboratory.....	1	Phys. 3b—Physics Laboratory.....	1
Physical Education.....	1½	Physical Education.....	1½
Military Science (for men).....	1	Military Science (for men).....	1
		Approved Elective.....	2
<i>Total</i>	17½	<i>Total</i>	18½

Third Year

Cer.E. 5—Ceramic Bodies.....	5	Cer.E. 11—Drying Clay Products... 3	
Cer.E. 7—Structural Clay Products..	3	Cer.E. 14—Glasses and Glazes.....	3
Cer.E. 21—Ceramic Pyrometry.....	1	Chem. 40—Physical Chemistry.....	3
Met. 1—Elements of Metallurgy.....	3	Chem. 41—Physical Chemistry Lab.	1
Geol. 20—General Mineralogy.....	3	Geol. 6—Optical Mineralogy.....	3
Phys. 16—Heat.....	3	Approved Elective.....	3
<i>Total</i>	18	<i>Total</i>	16

Fourth Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Cer.E. 22—Kilns and Burning.....	3	Cer.E. 20—Refractories.....	2
Cer.E. 97—Thesis.....	3	Cer.E. 28—Pyrochemical Problems..	2
Cer.E. 99—Inspection Trip.....	0	Cer.E. 98—Thesis.....	3
E.E. 4—D.C. and A.C. Circuits and Machines.....	2	Chem. 33—Organic Chemistry.....	5
E.E. 64—D.C. and A.C. Circuits and Machines Laboratory.....	1	Technical Option ¹	5
Approved Elective.....	3		
Technical Option ¹	6		
<i>Total</i>	18	<i>Total</i>	17

Curriculum in Chemical Engineering

For the Degree of Bachelor of Science in Chemical Engineering

This curriculum is administered by the College of Liberal Arts and Sciences.

First Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Chem. 8a—Inorganic Chemistry and Qualitative Analysis.....	5	Chem. 8b—Inorganic Chemistry and Qualitative Analysis.....	5
Math. 2—College Algebra.....	3	Math. 6a—Analytical Geometry.....	4
Math. 4—Plane Trigonometry ²	2	German or French.....	4
German or French.....	4	Rhet. 2—Rhetoric and Composition..	3
Rhet. 1—Rhetoric and Composition..	3	Hygiene 5.....	2
Physical Education.....		Physical Education.....	
Military Science (for men).....		Military Science (for men).....	
<i>Total</i>	17	<i>Total</i>	18

Second Year

Chem. 24—Quantitative Analysis....	5	Chem. 34—Organic Chemistry.....	5
Math. 8a—Differential Calculus....	3	Math. 8b—Integral Calculus.....	3
Physics 1a—General Physics.....	4	Physics 1b—General Physics.....	4
Physics 3a—Physics Laboratory....	1	Physics 3b—Physics Laboratory....	1
G.E.D. 6—Elements of Drawing....	3	T.A.M. 1—Analytical Mechanics....	2
Physical Education.....		Physical Education.....	
Military Science (for men).....		Military Science (for men).....	
<i>Total</i>	16	<i>Total</i>	15

Third Year

Chem. 36—Organic Chemistry.....	3	Chem. 42—Physical Chemistry.....	3
Chem. 37—Organic Chemistry Lab... 2		Chem. 63b—Chemical Engineering..	3
Chem. 40—Physical Chemistry.....	3	M.E. 2—Steam Engineering.....	3
Chem. 41—Physical Chemistry Lab... 1		E.E. 12—Alternating Current Apparatus.....	3
T.A.M. 3—Resistance of Materials... 3		E.E. 62—D.C. and A.C. Lab.....	1
T.A.M. 63—Resistance of Mat. Lab... 1		Electives.....	5
E.E. 11—Direct Current Apparatus.. 3			
E.E. 61—D.C. and A.C. Lab.....	1		
<i>Total</i>	17	<i>Total</i>	18

¹Technical Options: Ceramic Engineering 8, 10, 16, 17, 18, 23, 24; Chemistry 15a, 42, 43, 49b, 60a, 63b; Electrical Engineering 5, 65; Geology 43; Mechanical Engineering 1, 62; T.A.M. 1, 3; Mining 2; Metallurgy 12; Physics 14a, 14b, 78.

²Students with entrance credit in trigonometry are not required to take Mathematics 4.

Fourth Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Chem. 44a—Thermodynamics.....	2	Chem. 61b—Principles of Chemical Engineering.....	3
Chem. 60a—Chemical Engineering Unit Processes.....	3	Chem. 66b—Inspection Trip.....	1½
Chem. 61a—Principles of Chemical Engineering.....	3	Chem. 68b—Unit Operations Laboratory.....	2
Chem. 62a—Principles of Research and Development.....	2	M.E. 61—Mechanical Engineering Laboratory.....	2
Chem. 66a—Inspection Trip.....	1½	Electives ¹	10
Chem. 68a—Unit Operations Lab....	2		
Chem. 69a—Chemical Engineering Projects Laboratory.....	2		
Electives ¹	3		
<i>Total</i>	17½	<i>Total</i>	17½

Curriculum in Civil Engineering

For the Degree of Bachelor of Science in Civil Engineering

First Year

Common Program for Freshmen (page 45).

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
C.E. 1—Plane Surveying.....	3	C.E. 2—Topographic Surveying.....	3
C.E. 60—Bridge and Bldg. Constr....	3	Geol. 43—Engineering Geology ²	3
Math. 7—Differential Calculus.....	5	Math. 9—Integral Calculus.....	3
Phys. 1a—General Physics.....	4	Phys. 1b—General Physics.....	4
Phys. 3a—Physics Laboratory.....	1	Phys. 3b—Physics Laboratory.....	1
Physical Education.....	1½	T.A.M. 1—Analytical Mech. (Statics)	2
Military Science (for men).....	1	Physical Education.....	1½
		Military Science (for men).....	1
<i>Total</i>	17½	<i>Total</i>	17½

Note: Special third and fourth year curricula are available so that transfer students who have credit in all of the subjects included in the first and second year curricula except C.E. 1, 2, 60 and T.A.M. 1 can complete the requirements for the bachelor's degree in two years if they present an equivalent amount of credit.

Third Year

C.E. 30—Highway Materials Lab....	1	C.E. 3—Ry. and Hy. Surveying.....	4
C.E. 35—Plain Concrete.....	2	C.E. 20—Highway Construction.....	3
C.E. 36—Construction Materials.....	1	C.E. 62—Structural Design.....	3
C.E. 61—Structural Stresses.....	4	C.E. 63—Reinforced Concrete.....	2
M.E. 1—Steam, Air and Gas Machinery.....	3	E.E. 4 and 64—D.C. and A.C. Circuits and Machines, with Laboratory or Approved Elective.....	(3)
T.A.M. 2—Analyt. Mech. (Dynamics)	3	T.A.M. 4—Hydraulics.....	2
T.A.M. 3—Resistance of Materials...	3	T.A.M. 64—Hydraulics Laboratory..	1
T.A.M. 63—Res. of Materials Lab....	1		
<i>Total</i>	18	<i>Total</i>	18

¹Five hours of electives must be in courses for advanced undergraduates in chemistry or chemical engineering, approved by the adviser.

²Eight hours of credit in foreign language (French, German, or Spanish) may be substituted for Geology 43, 3 hours, and approved and non-technical electives, 5 hours.

Fourth Year

NOTE: Options are groups of related courses which can be logically taken together. It will be noted that all of the options have the same 26 hours of basic civil engineering courses, including C.E. 66 and 90. The remaining 9 hours of credit are either elective or are devoted to specialized courses. The general option permits a wide range of selection to meet the needs of students whose interests differ from those who choose the regular options.

ALL OPTIONS

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
C.E. 40—Water Supply.....	4	C.E. 41—Sewerage.....	3
C.E. 64—Structural Design.....	5	C.E. 65—Structural Design.....	4
C.E. 99—Inspection Trip.....	0	Options (See below).....	9 or 10
Options (See below).....	9 or 10		
<i>Total</i>	18 or 19	<i>Total</i>	16 or 17

GENERAL OPTION

C.E. 66—Masonry Construction.....	3	C.E. 90—Contracts and Specifications	2
Technical Elective.....	3	Technical Elective.....	5
Non-technical Elective.....	3	Approved Elective.....	3

HIGHWAY OPTION

C.E. 22—Highway and Municipal Design.....	4	C.E. 23—Highway Administration...	3
C.E. 50—Hydrology.....	2	C.E. 31—Advanced Hy. Materials...	2
Non-technical Elective.....	3	C.E. 66—Masonry Construction.....	3
		C.E. 90—Contracts and Specifications	2

HYDRAULIC OPTION

C.E. 50—Hydrology.....	2	C.E. 51—Drainage and Flood Control	3
C.E. 66—Masonry Construction.....	3	C.E. 55—Water Power.....	3
C.E. 90—Contracts and Specifications	2	E.E. 4—D.C. and A.C. Circuits and Machines.....	2
Non-technical Elective.....	3	E.E. 64—D.C. and A.C. Circuits and Machines Laboratory.....	1

RAILWAY OPTION

C.E. 25—Railway Construction and Maintenance.....	3	C.E. 26—Economics of Railway Location and Operation.....	3
C.E. 66—Masonry Construction.....	3	C.E. 27—Railway Yards and Terminals.....	2
Non-technical Elective.....	3	C.E. 90—Contracts and Specifications	2
		Approved Elective.....	3

SANITARY OPTION

C.E. 42—Water Purification.....	4	C.E. 43—Public Health Engineering	4
C.E. 90—Contracts and Specifications	2	C.E. 66—Masonry Construction.....	3
Bact. 5a—Bacteriology.....	3	E.E. 4—D.C. and A.C. Circuits and Machines.....	2
		E.E. 64—D.C. and A.C. Circuits and Machines Laboratory.....	1

STRUCTURAL OPTION

C.E. 67—Statically Indet. Structures	3	C.E. 66—Masonry Construction.....	3
C.E. 90—Contracts and Specifications	2	C.E. 68—Statically Indeterminate Structures.....	3
C.E. 91—Estimates and Costs.....	2	Approved Elective.....	3
Non-technical Elective.....	3		

Curriculum in Electrical Engineering

For the Degree of Bachelor of Science in Electrical Engineering

First Year

Common Program for Freshmen (page 45).

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
E.E. 14—Wiring and Illumination <i>or</i> Approved Elective ¹	3 or 4	E.E. 14—Wiring and Illumination <i>or</i> Approved Elective ¹	3 or 4
Math. 7—Differential Calculus.....	5	Math. 9—Integral Calculus.....	3
M.E. 85 <i>or</i> 87—Pattern and Foundry <i>or</i> Machine Tool Laboratory; <i>or</i> Ap- proved Elective ¹	3	M.E. 87 <i>or</i> 85—Machine Tool <i>or</i> Pat- tern and Foundry Laboratory; <i>or</i> Approved Elective ¹	3
Phys. 1a—General Physics.....	4	Phys. 1b—General Physics.....	4
Phys. 3a—Physics Laboratory.....	1	Phys. 3b—Physics Laboratory.....	1
Physical Education.....	1½	T.A.M. 1—Analytical Mech. (Statics)	2
Military Science (for men).....	1	Physical Education.....	1½
		Military Science (for men).....	1
<i>Total</i>	17½ or 18½	<i>Total</i>	17½ or 18½

Third Year

E.E. 25—Introduction to Circuit Analysis.....	4	E.E. 26—Direct Current Apparatus..	3
E.E. 75—Electrical Engineering Lab.	2	E.E. 76—Electrical Engineering Lab.	3
Math. 9a—Integral Calculus.....	2	E.E. 50—Introduction to Applied Electronics.....	2
M.E. 10—Thermodynamics; <i>or</i> Phys. 44a—Electrical and Magnetic Measurements.....	3	M.E. 10—Thermodynamics; <i>or</i> Phys. 44a—Electrical and Magnetic Measurements.....	3
T.A.M. 4—Analyt. Mech. (Dynamics)	3	T.A.M. 3—Resistance of Materials..	3
T.A.M. 4—Hydraulics.....	2	T.A.M. 63—Res. of Materials Lab... 1	
T.A.M. 64—Hydraulics Laboratory..	1	Approved Elective.....	3
<i>Total</i>	17	<i>Total</i>	18

Fourth Year²

E.E. 35—A.C. Apparatus.....	4	E.E. 36—A.C. Apparatus ⁴	4
E.E. 55—Electrical Design ³	2	E.E. 56—Economics of Electrical Sys- tems.....	4
E.E. 85—Electrical Engineering Lab.	2	E.E. 86—Electrical Engineering Lab. ⁴	2
E.E. 95—Seminar.....	1	E.E. 96—Seminar.....	1
E.E. 99—Inspection Trip.....	0	E.E. 98—Thesis ⁵ <i>or</i> Technical Elec- tive.....	3
M.E. 3—Power Plant Engineering... 3		Approved Elective.....	3 or 4
M.E. 61—Mech. Engineering Lab.... 2			
Non-technical Elective.....	3 or 4	<i>Total</i>	17 or 18
<i>Total</i>	17 or 18		

Curriculum in Engineering Physics

For the Degree of Bachelor of Science in Engineering Physics

The purpose of this curriculum is to prepare students for investigations in engineering problems calling for a knowledge of physics and mathematics or chemistry, and for positions in certain industries which prefer men with a thorough education in basic science.

¹One semester of E.E. 14 and one semester of M.E. 85 or 87 required.²E.E. 41, 42, and 44 may be substituted for other courses in the fourth year to emphasize railway electrical, or transit, engineering.³E.E. 51 or 54 may be substituted for E.E. 55.⁴Six hours from E.E. 48, 52, 54, 58, 59, 84, and 89 may be substituted for E.E. 36 and 86.⁵Only high-grade students are allowed to take a thesis course.

First Year

Common Program for Freshmen (page 45), except that Chem. 6 is substituted for Chem. 4.

Second Year¹

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
German <i>or</i> Approved Elective.....	4	German <i>or</i> Approved Elective.....	4
Math. 7—Differential Calculus.....	5	Math. 9—Integral Calculus.....	3
Phys. 1a—General Physics.....	4	Phys. 1b—General Physics.....	4
Phys. 3a—Physics Laboratory.....	1	Phys. 3b—Physics Laboratory.....	1
Physical Education.....	1½	T.A.M. 1—Analytical Mech. (Statics)	2
Military Science (for men).....	1	Physical Education.....	1½
Approved Elective.....	3	Military Science (for men).....	1
		Approved Elective.....	3
<i>Total</i>	18½	<i>Total</i>	18½

Third Year¹

E.E. 25—Introduction to Circuit Analysis.....	4	E.E. 26—Direct Current Apparatus..	3
E.E. 75—Electrical Engineering Lab.	2	E.E. 76—Electrical Engineering Lab.	3
German <i>or</i> Approved Elective.....	4	German <i>or</i> Approved Elective.....	4
Math. 18—Advanced Calculus ²	3	Math. 19—Advanced Calculus ²	3
Phys. 20a—Theoretical Mechanics... 3		Phys. 20b—Theoretical Mechanics... 3	
Phys. 40a—Elec. and Magnetism ³ 3		Phys. 40b—Elec. and Magnetism ³ 3	
<i>Total</i>	19	<i>Total</i>	18

Fourth Year¹

Chem. 40—Physical Chemistry.....	3	Phys. 60—Heat (M.E. 10 or 13 may be substituted).....	3
Phys. 71a—Light.....	2	Phys. 71b—Light.....	2
Phys. 72a—Light Laboratory.....	2	Phys. 72b—Light Laboratory.....	2
Phys. 199—Colloquium.....	0	Phys. 199—Colloquium.....	0
Approved Elective.....	3	Approved Elective.....	3
Technical Option ⁴	6	Technical Option ⁴	5
<i>Total</i>	16	<i>Total</i>	15

Curriculum in General Engineering*For the Degree of Bachelor of Science in General Engineering*

This curriculum is intended for students who do not wish to pursue the more specialized engineering curricula, but who wish to secure a sound education in engineering principles and their application. Fifteen hours of work in economics, business law, etc., are required, and fourteen hours of free electives are allowed. The degree of Bachelor of Science in General Engineering is awarded on completion of the curriculum.

First Year

Common Program for Freshmen (page 45).

¹The election of Chemistry 10, 24, and 34 is advised. Students wishing to emphasize chemistry may substitute chemistry electives for E.E. 25, 26, 75, 76. Students wishing to emphasize electrical engineering should elect E.E. 51, 52, 54, and/or 84 in their senior year. Students wishing to emphasize geophysics should elect most or all of the technical options in geology. Five hours must be approved non-technical courses.

²Math. 16 and 17 or Math. 71a-b may be substituted for Math 18 and 19.

³Physics 44 and 30 may be substituted for Physics 40a-40b.

⁴Technical Options: Chemistry 10, 24, 34, 36, 37, 41, 42, 43, 44; E.E. 51, 52, 54, 84; Geology 2a, 38, 43, 61; Math. 21, 22, 52, 53, 70, 71, 72; M.E. 35, 36, 87; any courses in Physics or Astronomy; T.A.M. 2, 3, 63.

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Econ. 2—Principles of Economics....	3	Geol. 43—Engineering Geology.....	3
Math. 7—Differential Calculus.....	5	Math. 9—Integral Calculus.....	3
M.E. 85—Pattern and Foundry Lab.; or C.E. 15—General Surveying....	3	C.E. 15—General Surveying; or M.E. 85—Pattern and Foundry Lab....	3
Phys. 1a—General Physics.....	4	Phys. 1b—General Physics.....	4
Phys. 3a—Physics Laboratory.....	1	Phys. 3b—Physics Laboratory.....	1
Physical Education.....	½	T.A.M. 1—Analytical Mech. (Statics)	2
Military Science (for men).....	1	Physical Education.....	½
		Military Science (for men).....	1
<i>Total</i>	17½	<i>Total</i>	17½

Third Year

Econ. 35—Corporations.....	3	C.E. 61—Structural Stresses.....	4
E.E. 11—D.C. and A.C. Circuits....	3	E.E. 12—D.C. and A.C. Apparatus..	3
E.E. 61—D.C. and A.C. Laboratory..	1	E.E. 62—D.C. and A.C. Laboratory..	1
M.E. 87—Machine Tool Laboratory..	3	M.E. 10—Thermodynamics.....	3
T.A.M. 2—Analyt. Mech. (Dynamics)	3	T.A.M. 4—Hydraulics.....	2
T.A.M. 3—Resistance of Materials...	3	T.A.M. 64—Hydraulics Laboratory..	1
T.A.M. 63—Res. of Materials Lab....	1	Approved Elective¹.....	4
<i>Total</i>	17	<i>Total</i>	18

Fourth Year

C.E. 86—Structural Design.....	4	Bus.Law 3—Law for Eng. Students; or Eng. 92—Engineering Law.....	3
Econ. 41—Labor Problems; or Eng. 39—Industrial Relations.....	3	C.E. 87—Structural Design.....	4
G.E. 99—Inspection Trip.....	0	Econ. 3—Money, Credit, Banking...	3
M.E. 3—Power Plant Engineering...	3	M.E. 64—Mechanical Engineering Laboratory.....	3
Met. 1—Elements of Metallurgy.....	3	Approved Elective¹.....	5
Approved Elective¹.....	5	<i>Total</i>	18
<i>Total</i>	18		

Curriculum in Mechanical Engineering

For the Degree of Bachelor of Science in Mechanical Engineering

First Year

Common Program for Freshmen (page 45).

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Approved Elective¹.....	3	Approved Elective¹.....	4
Math. 7—Differential Calculus.....	5	Math. 9—Integral Calculus.....	3
M.E. 85—Pattern and Foundry Lab.; or M.E. 87—Machine Tool Lab....	3	M.E. 87—Machine Tool Lab.; or M.E. 85—Pattern and Foundry Lab....	3
Phys. 1a—General Physics.....	4	Phys. 1b—General Physics.....	4
Phys. 3a—Physics Laboratory.....	1	Phys. 3b—Physics Laboratory.....	1
Physical Education.....	½	T.A.M. 1—Analytical Mech. (Statics)	2
Military Science (for men).....	1	Physical Education.....	½
		Military Science (for men).....	1
<i>Total</i>	17½	<i>Total</i>	18½

¹Eight hours or more in a foreign language (French, German, or Spanish) may be substituted for an equal number of hours of approved electives, subject to the general language requirements of the college.

Third Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
M.E. 13—Thermodynamics.....	3	M.E. 6—Power Plant Equipment....	4
M.E. 31—Mechanics of Machinery...	5	M.E. 14—Thermodynamics.....	3
T.A.M. 2—Analyt. Mech. (Dynamics)	3	M.E. 40—Mech. Engineering Design	3
T.A.M. 3—Resistance of Materials...	3	M.E. 64—Mech. Engineering Lab....	3
T.A.M. 63—Res. of Materials Lab....	1	M.E. 88—Machine Tool Laboratory	3
Non-technical Elective ¹	3	Non-technical Elective ¹	2
<i>Total</i>	18	<i>Total</i>	18

Fourth Year

E.E. 11—D.C. and A.C. Circuits....	3	E.E. 12—D.C. and A.C. Apparatus..	3
E.E. 61—D.C. and A.C. Laboratory..	1	E.E. 62—D.C. and A.C. Laboratory..	1
M.E. 41—Mech. Eng. Design.....	4	M.E. 28—Heating, Ventilating, and Air Conditioning.....	4
M.E. 65—Mech. Engineering Lab....	3	M.E. 52—Power Plant Design.....	3
M.E. 89—Heat Treatment of Metals; or Non-technical Elective ¹	3	M.E. 89—Heat Treatment of Metals; or Non-technical Elective ¹	3
Technical Option (See below).....	3	Technical Option (See below).....	3
M.E. 99—Inspection Trip.....	0		
<i>Total</i>	17	<i>Total</i>	17

CURRICULUM OPTIONS

Curriculum Options are groups of related courses which can be logically taken together and thus emphasize certain subdivisions, or fields, of Mechanical Engineering.

PETROLEUM PRODUCTION ENGINEERING

Substitute in the Mechanical Engineering Curriculum as follows:

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Geol. 43 for Approved Elective.....	3	Geol. 2a for Approved Elective.....	4

Third Year

C.E. 15 for Non-technical Elective...	3	Non-technical Elective.....	3
---------------------------------------	---	-----------------------------	---

Fourth Year

M.E. 35, T.A.M. 4 and 64, and Geol. 61a for M.E. 41 and Technical Op- tion.....	9	M.E. 36, Geol. 60b, and Geol. 61b for M.E. 28 and 52 and Technical Op- tion.....	8
---	---	--	---

RAILWAY MECHANICAL ENGINEERING

Substitute in Mechanical Engineering Curriculum as follows:

Fourth Year

M.E. 5 for Technical Option.....	3	M.E. 8 for Technical Option.....	3
		M.E. 54 for M.E. 52.....	3

¹Special attention is called to Eng. 10 (Engineering Economics), Eng. 20 (History of Engineering), Eng. 39 (Industrial Relations), Eng. 40 (Transportation Development), Eng. 41 (Transportation Problems), and Eng. 92 (Engineering Law).

TECHNICAL OPTIONS

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
M.E. 5—Locomotives.	3	M.E. 7—Int. Combustion Engines. . .	3
M.E. 7—Int. Combustion Engines. . .	3	M.E. 8—Railway Operation.	3
M.E. 17—Refrigeration Engineering. .	3	M.E. 15—Engineering Thermody-	
M.E. 33—Aeronautical Engineering. .	3	namics.	3
M.E. 35—Petroleum Production Eng. .	3	M.E. 17—Refrigeration Engineering	3
M.E. 84—Welding Engineering. . . .	3	M.E. 34—Aeronautical Engineering. .	3
T.A.M. 4 and 64—Hydraulics.	3	M.E. 54—Locomotive and Car Design	3
T.A.M. 41—Advanced Mechanics. . . .	3	M.E. 36—Petroleum Production Eng. .	3
T.A.M. 43—Hydraulics Laboratory. . .	3	M.E. 84—Welding Engineering. . . .	3
T.A.M. 44—Testing Materials.	3	T.A.M. 4 and 64—Hydraulics.	3
T.A.M. 47—Engineering Analysis. . . .	3	T.A.M. 42—Engineering Materials. . .	3
T.A.M. 49—Advanced Dynamics and		T.A.M. 43—Hydraulics Laboratory. . .	3
Vibrations.	3	T.A.M. 44—Testing Materials.	3
C.E. 89—Structural Engineering. . . .	3	T.A.M. 48—Engineering Analysis. . .	3
		T.A.M. 50—Advanced Dynamics and	
		Vibrations.	3

Curriculum in Metallurgical Engineering

For the Degree of Bachelor of Science in Metallurgical Engineering

First Year

Common Program for Freshmen (page 45), except that Chem. 5 is substituted for Chem. 4.

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Chem. 22—Quantitative Analysis. . . .	5	C.E. 15—General Surveying.	3
Math. 8a—Differential Calculus. . . .	3	Math. 8b—Integral Calculus.	3
Phys. 1a—General Physics.	4	M.E. 85—Pattern and Foundry Lab.;	
Phys. 3a—Physics Laboratory.	1	or German or French.	3 or 4
Physical Education.	$\frac{1}{2}$	Phys. 1b—General Physics.	4
Military Science (for men).	1	Phys. 3b—Physics Laboratory.	1
Approved Elective or German or		T.A.M. 1—Analytical Mechanics. . . .	2
French.	3 or 4	Physical Education.	$\frac{1}{2}$
		Military Science (for men).	1
<i>Total.</i>	$17\frac{1}{2}$ or $18\frac{1}{2}$	<i>Total.</i>	$17\frac{1}{2}$ or $18\frac{1}{2}$

Third Year

Cer.E. 21—Pyrometry.	1	Chem. 48b—Physical Chemistry. . . .	3
Chem. 48a—Physical Chemistry. . . .	3	Met. 5—Ferrous Metallurgy.	3
Geol. 20—Mineralogy.	3	Met. 6—Metallurgical Calculations. .	2
Met. 2—Principles of Metallurgy. . . .	3	Met. 13—Utilization of Fuels.	3
Met. 4—Physical Metallurgy.	3	M.E. 62—Mech. Eng. Lab.	3
Min. 9—Coal and Ore Preparation. . . .	3	T.A.M. 3—Resistance of Materials. . .	3
T.A.M. 2—Analyt. Mech. (Dynamics) .	3	T.A.M. 63—Res. of Materials Lab. . .	1
<i>Total.</i>	19	<i>Total.</i>	18

Fourth Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
E.E. 4—D.C. and A.C. Circuits and Machines.....	2	E.E. 5—Applications of Electrical Equipment.....	2
E.E. 64—D.C. and A.C. Circuits and Machines Laboratory.....	1	E.E. 65—Electrical Equipment Laboratory.....	1
Met. 7—Ferrous Metallography.....	3	Met. 10—Non-ferrous Metallography.....	3
Met. 8—Ferrous Metallography Lab.....	2	Met. 11—Electrometallurgy.....	3
Met. 9—Non-ferrous Metallurgy.....	3	Met. 42—Metallurgical Design.....	2
Met. 41—Metallurgical Design.....	3	Min. 2—Mining Principles or Approved Elective.....	3 ¹
Met. 99—Inspection Trip.....	0	Min. 90—Seminar.....	1
Approved Elective.....	2	T.A.M. 4—Hydraulics.....	2
		T.A.M. 64—Hydraulics Laboratory..	1
<i>Total</i>	16	<i>Total</i>	18 ¹

Curriculum in Mining Engineering*For the Degree of Bachelor of Science in Mining Engineering***First Year**

Common Program for Freshmen (page 45), except that Chem. 5 is substituted for Chem. 4.

Second Year

FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Chem. 22—Quantitative Analysis....	5	C.E. 15—General Surveying.....	3
Math. 8a—Differential Calculus.....	3	Geol. 43—Engineering Geology.....	3
Phys. 1a—General Physics.....	4	Math. 8b—Integral Calculus.....	3
Phys. 3a—Physics Laboratory.....	1	Phys. 1b—General Physics.....	4
Physical Education.....	1½	Phys. 3b—Physics Laboratory.....	1
Military Science (for men).....	1	T.A.M. 1—Analytical Mech. (Statics)	2
Approved Elective.....	3	Physical Education.....	1½
		Military Science (for men).....	1
<i>Total</i>	17½	<i>Total</i>	17½

Third Year

Geol. 20—Mineralogy.....	3	Min. 4—Mining Methods.....	4
Min. 1—Elements of Mining.....	4	T.A.M. 3—Resistance of Materials..	3
Min. 62—Mine Surveying.....	3	T.A.M. 63—Res. of Materials Lab..	1
T.A.M. 2—Analytical Mechanics (Dynamics).....	3	T.A.M. 4—Hydraulics.....	2
Option (See page 58).....	6	T.A.M. 64—Hydraulics Laboratory..	1
<i>Total</i>	19	Option (See page 58).....	5 or 7
		<i>Total</i>	16 or 18

Fourth Year

E.E. 4—D.C. and A.C. Circuits and Machines.....	2	E.E. 5—Applications of Electrical Equipment.....	2
E.E. 64—D.C. and A.C. Circuits and Machines Laboratory.....	1	E.E. 65—Electrical Equipment Laboratory.....	1
Min. 9—Preparation of Coal and Ore	3	Min. 15—Mine Ventilation.....	2
Min. 41—Mining Design.....	3	Min. 21—Examination, Valuation, and Reports.....	3
Min. 99—Inspection Trip.....	0	Min. 42—Mining Design.....	2
Option (See page 58).....	8 or 9	Min. 90—Seminar.....	1
		Option (See page 58).....	6-8
<i>Total</i>	17 or 18	<i>Total</i>	17-19

¹Students who took German or French in the sophomore year require only one hour of approved elective, or a total of 16 hours for the semester.

OPTIONS FOR THE CURRICULUM IN MINING ENGINEERING

COAL MINING OPTION

<i>Third Year</i>			
FIRST SEMESTER	HOURS	SECOND SEMESTER	HOURS
Accy. 12—Fundamentals of Accounting.....	3	M.E. 62—Mech. Eng. Laboratory...	3
Approved Elective.....	3	Approved Elective.....	2
<i>Fourth Year</i>			
Met. 1—Elements of Metallurgy.....	3	Met. 13—Utilization of Fuels.....	3
Min. 6—Mech. Eng. of Mines.....	3	Min. 20—Mine Ventilation Lab.....	2
Min. 8—Mine Administration.....	3	Min. 64—Coal and Ore Prep. Lab....	2

ORE MINING OPTION

<i>Third Year</i>			
Accy. 12—Fundamentals of Accounting.....	3	M.E. 62—Mech. Eng. Laboratory...	3
Approved Elective.....	3	Approved Elective.....	2
<i>Fourth Year</i>			
Met. 1—Elements of Metallurgy.....	3	Geol. 96—Economic Geology.....	3
Met. 3—Fire Assaying.....	2	Min. 6—Mech. Eng. of Mines.....	3
Min. 8—Mine Administration.....	3	Min. 64—Coal and Ore Prep. Lab....	2

MINING GEOLOGY OPTION

<i>Third Year</i>			
Geol. 2a—Historical Geology.....	4	Geol. 49—Microscopic Mineralogy...	5
Approved Elective.....	2	Approved Elective.....	2
<i>Fourth Year</i>			
Geol. 95—Economic Geology.....	3	Geol. 96—Economic Geology.....	3
Met. 3—Fire Assaying.....	2	Min. 12—Mining Geology.....	3
Approved Elective.....	3		

MINE ADMINISTRATION OPTION

<i>Third Year</i>			
Accy. 12—Fundamentals of Accounting.....	3	Econ. 3—Money, Credit, and Banking	3
Econ. 2—Elements of Economics.....	3	Approved Elective.....	2
<i>Fourth Year</i>			
Econ. 35—Corporation Finance.....	3	Min. 6—Mech. Eng. of Mines.....	3
Min. 8—Mine Administration.....	3	Approved Elective.....	3
Eng. 92—Engineering Law.....	3		

Courses Offered in the College of Engineering

THE FOLLOWING LIST of courses offered in the College of Engineering is arranged alphabetically by names of departments. Names of staff members in each department (as of September, 1940) are listed by rank and by seniority of appointment within each rank, except the head of the department who is listed first. (For complete names, with degrees and titles, see page 5.) The courses offered by each department are listed numerically in groups with headings to indicate the students for whom they are designed. The description of each course shows its content or purpose, the terms during which it is offered, and its credit value. Terms of the year are represented by symbols: "I" for the first semester, and "II" for the second semester. Courses extending through both semesters are designated as "continuous through I and II."

Credit for undergraduate students is counted in *semester hours*. A semester hour represents the work of one classroom period of fifty minutes each week through one semester, or the equivalent in laboratory, shop, or drafting room. In descriptions of courses the credit values are shown in parentheses: for example, "(3)" meaning three hours of credit each semester.

Credit for graduate students is counted in *units*. A unit course requires approximately ten hours of time each week through one semester. Four such courses constitute a student's normal program for a semester. In descriptions of courses for graduates the unit values per semester are stated in parentheses.

Prior to the beginning of each semester, the University publishes a *Time Table* listing all courses offered by the departments at Urbana, and showing the time and place of meeting of classes. Each student is supplied with a copy of the *Time Table* when he registers. Some courses are given also in the summer sessions, and a special pamphlet announcing them is issued in the spring of each year.

CERAMIC ENGINEERING

Professors: PARMELEE (Head of the Department), HURSH, ANDREWS.
Instructors: HARMAN, PASK, COOK.
Assistants: ZINK.

Courses for Undergraduates

1. CERAMIC MATERIALS.—Properties of clays and other ceramic materials. Lectures. I, (3). *Prerequisite*: Chemistry 6.
4. CERAMIC MATERIALS.—Laboratory. II, (3). *Prerequisite*: Ceramic Engineering 1.
5. CERAMIC BODIES.—Composition and properties, effects of ingredients, special bodies. Lectures and laboratory. I, (5). *Prerequisite*: Ceramic Engineering 1 and 4.
7. STRUCTURAL CLAY PRODUCTS.—Manufacture and testing of brick, tile, hollow tile, sewer pipe, etc. Lectures and field trips. I, (3). *Prerequisite*: Ceramic Engineering 1 and 4.
8. GLASS TECHNOLOGY.—The chemistry and physics of the silicate glasses and their preparation; industrial methods. Lectures and discussion. II, (2). *Prerequisite*: Chemistry 40; Ceramic Engineering 14.
10. CEMENTS.—Cements, limes, plasters; composition, reactions; methods of manufacture and testing. Lectures. II, (2). *Prerequisite*: Chemistry 40; registration in Ceramic Engineering 28.

11. DRYING CLAY PRODUCTS.—Drying, drying equipment, construction and regulation of dryers. Lectures. II, (3). *Prerequisite:* Physics 1a-1b and 3a-3b; Ceramic Engineering 1.
14. GLASSES AND GLAZES.—The properties of glasses and glazes as influenced by composition; types of glazes, preparation and uses. Lectures and laboratory. II, (3). *Prerequisite:* Ceramic Engineering 5; registration in Chemistry 40.
16. ENAMELS.—Composition, preparation, application, properties, and tests. Lectures and quiz. II, (3). *Prerequisite:* Registration in Ceramic Engineering 14.
17. ENAMELS.—Composition, application, properties, and testing. Lectures and laboratory. I, (3). *Prerequisite:* Ceramic Engineering 14 and 16.
18. CERAMIC MICROSCOPY.—I and II, (3). *Prerequisite:* Chemistry 40; Geology 6 and 20, or equivalent.
20. REFRACTORY MATERIALS.—Composition and properties of refractory materials and products, and their adaptability to conditions of service. Lectures and discussions. II, (2). *Prerequisite:* Chemistry 40.
21. CERAMIC PYROMETRY.—Principles and methods used in high temperature measurement. Lectures. I and II, (1). *Prerequisite:* General physics; inorganic chemistry.
22. KILNS AND THE BURNING OF CLAY PRODUCTS.—The burning process, utilization of fuels, types of kilns and their operation. Lectures. I, (3). *Prerequisite:* Ceramic Engineering 5 and 11.
23. DRYER AND KILN DESIGN.—Design problems. Laboratory. I, (2). *Prerequisite:* Ceramic Engineering 11; registration in Ceramic Engineering 22; General Engineering Drawing 1 or 4.
24. CERAMIC ENGINEERING DESIGN.—Design of special ceramic equipment, factory planning and layout. Laboratory. II, (3). *Prerequisite:* Ceramic Engineering 23; Theoretical and Applied Mechanics 3.
28. PYROCHEMICAL PROBLEMS.—The Phase Rule; graphic representation and interpretation of the chemistry and mineralogy of ceramics. Lectures. II, (2). *Prerequisite:* Ceramic Engineering 14; Chemistry 40.
- 97-98. THESIS.—Continuous through I and II, (0 to 3).
99. INSPECTION TRIP.—Visits to industrial plants. I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—This department offers graduate work leading to the degrees of Master of Science in Ceramics, Master of Science in Ceramic Engineering, Doctor of Philosophy in Chemistry (Ceramic Chemistry), and Doctor of Philosophy in Engineering.

The prerequisite for a major in graduate work in ceramics or ceramic engineering is proficiency in the undergraduate courses required for a bachelor's degree in the branch of the subject in which registration is desired.

Candidates for the degree of Doctor of Philosophy in Chemistry (Ceramic Chemistry) must have had the equivalent of at least 25 semester hours of satisfactory courses in general, analytical, physical, and organic chemistry; also calculus, one year of college physics, one semester of optical mineralogy, and at least 18 semester hours or their equivalent in acceptable ceramic courses.

101. CHEMISTRY OF THE COMPOUNDS OF SILICON.—Seminar. I and II, (1 unit). Professor PARMELEE.
102. GENERAL TECHNOLOGY OF THE SILICATE INDUSTRIES.—Chemical and physical problems related to the utilization of ceramic materials. Lectures, seminar, and laboratory. I and II, (1 to 2 units).
 - (a) CERAMIC MATERIALS AND PROCESSES.—Professor PARMELEE.
 - (b) DRYING AND FIRING PROCESSES.—Professor HURSH.
 - (c) ENAMELS AND EQUILIBRIUM STUDIES.—Professor ANDREWS.
 - (d) REFRACTORIES.—Professor ANDREWS.
103. CHEMISTRY OF SILICATES.—Laboratory to supplement Ceramic Engineering 101, which must precede or accompany it. I and II, (1 to 2 units). Professors PARMELEE, HURSH, and ANDREWS.
104. TECHNOLOGY OF GLASS.—Physical and chemical properties of glasses. Lectures and laboratory. II, (1 to 2 units). Professor PARMELEE, Dr. BADGER.
105. METHODS OF CERAMIC RESEARCH.—Present status of ceramic research—its methods and apparatus; analysis of data. II, (1 to 4 units). Professor PARMELEE.
106. RESEARCH.—I and II. Professors PARMELEE, HURSH, and ANDREWS.

CIVIL ENGINEERING

Professors: HUNTINGTON (Head of the Department), WILSON, BABBITT,

CRANDELL, PICKELS, DOLAND, SHEDD, VAWTER, WILEY, KING.

Assistant Professors: RAYNER, BAUER, OLIVER, NEWMARK.

Associates: DELL, EVANS, BRIELMAIER.

Instructors: CLARK.

Cooperating: Mr. R. S. CROSSMAN, Mr. L. D. WALKER, Mr. B. O. LARSON.

Courses for Undergraduates

1. PLANE SURVEYING.—Use and care of instruments; practice in the common field methods of measuring distance, angles, and elevations; computations of areas and volumes; land survey and re-survey methods; legal principles; problems. I and II, (3). *Prerequisite:* General Engineering Drawing 1 or 4; Mathematics 4.
2. TOPOGRAPHIC SURVEYING.—Contours, map construction and volumetric estimates from contour maps; astronomical determination of latitude and azimuth; transit-stadia methods of topographic surveying; survey and map of an assigned area. II, (3). *Prerequisite:* Civil Engineering 1.
3. RAILWAY AND HIGHWAY SURVEYING.—Horizontal and vertical alinement for railroads and highways; grades and grade reduction; curves, turnouts, and earthwork; principles of economic location; surveys, plans, and estimates. I and II, (4). *Prerequisite:* Civil Engineering 2, 15, or 18.
15. GENERAL SURVEYING.—Use and care of surveying instruments; computations of areas and volumes; transit-stadia mapping methods; contour problems. For students in other departments. I and II, (3). *Prerequisite:* General Engineering Drawing 1 or 4; Mathematics 4.
16. ELEMENTARY SURVEYING.—For students in ceramic engineering. II, (2). *Prerequisite:* Mathematics 4; General Engineering Drawing 1 or 4.
17. SURVEYING FOR LANDSCAPE ARCHITECTS.—Field problems; use of instruments, note-keeping, signals, basic surveying operations; office problems. I, (3). *Prerequisite:* Mathematics 4.
18. SURVEYING FOR LANDSCAPE ARCHITECTS.—Use and construction of contour maps; methods of mapping; computation of earthwork; office problems; actual surveys. II, (3). *Prerequisite:* Civil Engineering 17.
19. CONSTRUCTION SURVEYING.—The principles of surveying as applied to construction work on bridges, buildings, tunnels, sewers, etc. II, (3). *Prerequisite:* Civil Engineering 3; Mathematics 7.
20. HIGHWAY CONSTRUCTION.—Soils, drainage, and materials of construction for roads and pavements; construction of earth, gravel, and macadam roads; city and rural pavement construction, repairs and maintenance; accessories; resurfacing; width and capacity of roads and streets; estimates. I and II, (3). *Prerequisite:* Civil Engineering 2, 15, or 18, or consent of instructor.
22. HIGHWAY AND MUNICIPAL DESIGN.—Road systems, city streets, pavement types; design, preparation of plans, specifications, and estimates of cost. I, (4). *Prerequisite:* Civil Engineering 20, or consent of instructor.
23. HIGHWAY ADMINISTRATION.—Relation of road and street improvement to social and economic welfare; highway organization; highway and pavement financing. II, (3). *Prerequisite:* Civil Engineering 20, or consent of instructor.
25. RAILWAY CONSTRUCTION AND MAINTENANCE.—Earthwork and rockwork; track materials; track stresses; and track design. I, (3). *Prerequisite:* Civil Engineering 3.
26. ECONOMICS OF RAILWAY LOCATION AND OPERATION.—Influence of volume of traffic, alignment, and gradient upon operating expenses. II, (3). *Prerequisite:* Civil Engineering 3.
27. RAILWAY YARDS AND TERMINALS.—Freight sorting yards; mechanical facilities; passenger terminals. II, (2). *Prerequisite:* Civil Engineering 3.
28. REGIONAL DESIGN.—Preparation of plans for a metropolitan regional development, including the coordination of highway, railway, and airway transport. General features of water supply and sewage disposal are included. II, (3). *Prerequisite:* Civil Engineering 20; senior standing.
29. RAILWAY SIGNALING.—Block and route signaling; train and central traffic control. I, (2). *Prerequisite:* Junior standing in engineering.

30. HIGHWAY MATERIALS LABORATORY.—Laboratory practice in testing of asphalts, tars, road oils, bituminous mixtures, stone, gravel, and paving brick. I and II, (1). *Prerequisite:* Junior standing in engineering, architecture, or landscape architecture.
31. ADVANCED HIGHWAY MATERIALS.—Advanced work in the examination and testing of bituminous materials and mixtures, portland cement concrete, and soils for engineering purposes. Each student selects one material for special study. II, (2). *Prerequisite:* Civil Engineering 30, 32, or 35.
32. ENGINEERING PROPERTIES OF SOILS.—Origin, formation, development, classification, identification, and characteristics of soils; engineering soil surveys; sampling; compaction of embankments; frost action; and laboratory practice in testing of soils. I and II, (2). *Prerequisite:* Senior standing in engineering, or consent of instructor.
35. PLAIN CONCRETE.—Tests for portland cement; aggregates; field and laboratory examination and tests; proportioning. Laboratory practice. I and II, (2). *Prerequisite:* Junior standing in engineering, architecture, or landscape architecture.
36. CONSTRUCTION MATERIALS.—Manufacture, properties, and use of cast iron, wrought iron, steel and other metals, brick and terra cotta; formation, properties, and use of stone; growth, properties, and use of timber. This course supplements Civil Engineering 30, 31, and 35. I and II, (1). *Prerequisite:* Junior standing in engineering, architecture, or landscape architecture.
40. WATER SUPPLY.—Finances, hydraulics, demand, sources, reservoirs, pipe lines, pumping machinery, materials, distribution systems. I and II, (4). *Prerequisite:* Theoretical and Applied Mechanics 3, 4, and 64; Mechanical Engineering 1 or 2.
41. SEWERAGE.—Sewerage systems, surveys and plants, hydraulics, house sewerage, rainfall and storm-water flow, size and capacity of sewers, appurtenances, estimates and specifications, construction. I and II, (3). *Prerequisite:* Theoretical and Applied Mechanics 4 and 64.
42. WATER PURIFICATION.—Design of water purification works; standards and tests of purity of potable water. Lectures, seminar work, design, and laboratory practice. I, (4). *Prerequisite:* Registration or credit in Civil Engineering 40; Bacteriology 5a.
43. PUBLIC HEALTH ENGINEERING.—Principles of sanitation, design of sewage treatment works, garbage disposal, sanitary regulations. Lectures, seminar work, and design. II, (4). *Prerequisite:* Civil Engineering 42; registration or credit in Civil Engineering 41.
49. MUNICIPAL SANITATION.—General sanitation, water supply, storm water, sewage treatment and wastes disposal with particular reference to the general problems of city planning. For students in other departments. I, (3). *Prerequisite:* Junior standing.
50. HYDROLOGY.—Precipitation, evaporation, transpiration, deep seepage, run-off, hydraulics of rivers and small streams; use of current meter, float, weir, etc. I, (2). *Prerequisite:* Senior standing in engineering.
51. DRAINAGE AND FLOOD CONTROL.—Land drainage, river improvement, flood control. II, (3). *Prerequisite:* Civil Engineering 50.
55. WATER POWER.—Rainfall and stream flow records; estimate of available power; theory and testing of turbines; dams, power house, approach channels, draft tubes; relation of investment costs, auxiliary plants, and other factors to the values of projects. II, (3). *Prerequisite:* Theoretical and Applied Mechanics 4 and 64.
60. BRIDGE AND BUILDING CONSTRUCTION.—Materials, types of construction, and details for bridges and buildings. I and II, (3). *Prerequisite:* Sophomore standing.
61. STRUCTURAL STRESSES.—Analysis of stresses in statically determinate structures. I and II, (4). *Prerequisite:* Registration or credit in Theoretical and Applied Mechanics 3.
62. ELEMENTARY STRUCTURAL DESIGN.—Elementary design and details of simple structures of steel, concrete, and timber. I and II, (3). *Prerequisite:* Registration or credit in Civil Engineering 61.
63. THEORY OF REINFORCED CONCRETE.—I and II, (2). *Prerequisite:* Theoretical and Applied Mechanics 3; registration or credit in Civil Engineering 61.
64. STRUCTURAL DESIGN.—Theory of design and design of structures of steel, concrete, and timber. Primarily building design. I and II, (5). *Prerequisite:* Civil Engineering 62 and 63.

65. **STRUCTURAL DESIGN.**—Continuation of Civil Engineering 64, devoted principally to bridges. I and II, (4). *Prerequisite:* Civil Engineering 64.
66. **MASONRY CONSTRUCTION.**—Dams, retaining walls, bridge piers and abutments, shallow bins, deep bins, culverts, arches, foundations, and soil mechanics. I and II, (3). *Prerequisite:* Civil Engineering 61 and 63.
67. **STATICALLY INDETERMINATE STRUCTURES.**—Elastic theory and its applications to statically indeterminate structures. I, (3). *Prerequisite:* Registration or credit in Civil Engineering 64. Civil Engineering 67 is recommended for graduate students who have not had similar training.
68. **STATICALLY INDETERMINATE STRUCTURES.**—Continuation of Civil Engineering 67. II, (3). *Prerequisite:* Civil Engineering 67.
86. **STEEL, CONCRETE, AND TIMBER DESIGN.**—Design of structures of steel, concrete, and timber. For students in other departments. I, (4). *Prerequisite:* Civil Engineering 61.
87. **STEEL, CONCRETE, AND TIMBER DESIGN.**—Continuation of Civil Engineering 86. II, (4). *Prerequisite:* Civil Engineering 86.
89. **STRUCTURAL ENGINEERING.**—Design of steel, reinforced concrete, and timber structures. For students in other departments. I, (3). *Prerequisite:* Senior standing in engineering or architecture.
90. **CONTRACTS AND SPECIFICATIONS.**—Engineering relations; the law of contracts; business and technical clauses used in specifications. I and II, (2). *Prerequisite:* Senior standing in engineering or architecture.
91. **ESTIMATES AND COSTS.**—Economic selection; construction cost estimating; direct and overhead costs; cost keeping; construction by force account and contract; time schedules and progress charts; valuation. I and II, (2). *Prerequisite:* Senior standing in engineering or architecture.
- 97-98. **THESIS.**—Investigation or design. May be substituted for certain technical subjects in any of the five options of the senior year. Continuous through I and II, (1 to 3). *Prerequisite:* Senior standing and consent of head of department.
99. **INSPECTION TRIP.**—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—The prerequisite for graduate work in civil engineering is the equivalent of the undergraduate curriculum required for a bachelor's degree in the branch of the subject in which registration is desired.

101. **WATER SUPPLY.**—Design, pumping machinery, administration, operation. I, (1 unit). Professor BABBITT.
102. **SEWERAGE.**—Sewer design, construction, maintenance, operation, and financing. II, (1 unit). Professor BABBITT.
103. **HIGHWAY ENGINEERING.**—Detailed examination of all paving materials and methods of construction; experimental pavements; road improvements; soil stabilization; machinery for highway construction; city, state, and regional planning; airports; and future planning. I, (1 unit). Professor CRANDELL.
104. **MUNICIPAL ENGINEERING.**—City finances and budgets, the work of the city manager and city engineer, zoning, playgrounds and parks, street cleaning, smoke prevention, and fire prevention. II, (1 unit). Professor CRANDELL.
105. **REINFORCED CONCRETE DESIGN.**—Theories of action of beams, slabs, and columns of reinforced concrete; codes and specifications and their influence on design; effect of continuity. I, (1 unit). Professor SHEDD.
106. **STRUCTURAL THEORY AND DESIGN.**—General theory of continuity; moment distribution; the column analogy; rigid frame bridges and buildings; fixed and continuous arches; classification of structures from viewpoint of design. I, (1 or 2 units). Professor SHEDD.
107. **STEEL DESIGN.**—Design of steel members; codes and specifications for buildings; riveted and welded connection; evolution of bridge specifications; loads and working stresses; economic proportions. II, (1 unit). Professor SHEDD.
108. **STRUCTURAL THEORY AND DESIGN.**—Statically indeterminate trusses; continuous trusses; steel arches; secondary stresses; suspension bridges; long-span roofs; skeleton steel buildings. II, (1 or 2 units). Professor SHEDD.
109. **PUBLIC HEALTH ENGINEERING.**—Design of water purification works and principles of sanitation. I, (1 unit). Professor BABBITT.

110. SEWAGE DISPOSAL, WASTES DISPOSAL, AND GENERAL SANITATION.—Principles and design of sewage treatment and waste disposal works. II, (1 unit). Professor BABBITT.
112. MASONRY CONSTRUCTION.—Design and construction of dams, earth embankments, retaining walls, abutments and piers, culverts, grain elevators, and bins. I, (1 unit). Professor HUNTINGTON.
113. SOIL MECHANICS AND FOUNDATIONS.—Geological considerations; sub-surface exploration; classification, properties and tests for rock and soil; stress distribution under foundations; consolidation and settlement; percolation and seepage; spread footings; pile foundations; cofferdams; deep foundations; dam foundations. II, ($\frac{1}{2}$ to 1 unit). Professor HUNTINGTON, Assistant Professors BAUER and NEWMARK.
114. ANALYTICAL STUDY OF TESTS OF STRUCTURAL STEEL MEMBERS.—Planning tests, limitations of experimental methods, interpretation of results in terms of design practice. II, (1 unit). Professor WILSON.
120. HIGHWAY TRAFFIC, TRANSPORT, AND SAFETY.—Development, distribution, and characteristics of highway traffic; traffic survey methods and analysis; traffic laws and regulations; traffic control methods and devices; causes and prevention of accidents; accident reports and analysis; safety methods, programs, and education. I and II, (1 unit). Professor WILEY.
125. RAILWAY LOCATION AND OPERATION.—Railway location; track capacity; tonnage ratings. I and II, (1 unit). Professor KING.
130. HYDROLOGY AND FLOOD CONTROL.—Magnitude and frequency of flood flow of streams, minimum flow of streams and regulation of flow by storage reservoirs, intense rainfall and the development of intensity curves for use in rational run-off formula, unit-graph method of computing flood run-off, flood control and prevention channel improvement, levees and reservoirs. I, (1 unit). Professor PICKELS.
131. WATER POWER.—Preliminary investigations, selection of site, storage requirements, structures, machinery, etc. II, (1 unit). Professor DOLAND.
140. SPECIAL PROBLEMS.—Individual investigations or studies of various phases of civil engineering. I and II, ($\frac{1}{2}$ to 2 units). Members of the department.
198. THESIS.—I and II, (1 to 2½ units). Members of the department.

ELECTRICAL ENGINEERING

Professors: PAINE (Head of the Department), BROOKS (Emeritus), TYKOCINER, KNIGHT, BROWN, KRAEHNBUHL, REICH.
 Associate Professors: REID, WALDO (Emeritus), KEENER, TUTHILL.
 Assistant Professors: FAUCETT, ARCHER, SKRODER.
 Associates: HAYWARD, L. L. SMITH, WARREN.
 Instructors: FETT, HORN, HELM, MACE, PEIRCE, J. H. SMITH.
 Assistants: GIBSON.

Courses for Undergraduates

4. DIRECT AND ALTERNATING CURRENT CIRCUITS AND MACHINES.—Fundamental principles of electrical circuits and machines. For students in agricultural, ceramic, civil, and mining engineering, and ceramics. I and II, (2). *Prerequisite:* Physics 1a, 1b, 3a, 3b; Mathematics 8b or 9; registration in Electrical Engineering 64.
5. APPLICATIONS OF ELECTRICAL EQUIPMENT.—Applications of electricity for industrial uses. For students in ceramic and mining engineering. II, (2). *Prerequisite:* Electrical Engineering 4, 64; registration in Electrical Engineering 65.
11. DIRECT AND ALTERNATING CURRENT CIRCUITS.—Fundamental electric and magnetic units and circuits, direct and alternating currents. For students in agricultural, chemical, general, mechanical, and railway engineering, and industrial administration. I, (3). *Prerequisite:* Physics 1a, 1b, 3a, 3b; Mathematics 8b or 9; registration in Electrical Engineering 61.
12. DIRECT AND ALTERNATING CURRENT APPARATUS.—Generators and motors, transformers, rectifiers, and electronic devices. II, (3). *Prerequisite:* Electrical Engineering 11, 61; registration in Electrical Engineering 62.

14. **WIRING AND ILLUMINATION.**—Fundamentals of commercial and industrial wiring and illumination practice. I and II, (3). Not open to students with credit in Electrical Engineering 90 and 92. *Prerequisite:* Sophomore standing, or equivalent.
25. **INTRODUCTION TO CIRCUIT ANALYSIS.**—Electric and magnetic units and circuits; graphical and mathematical treatment of periodic current circuits; special problems in alternating current networks; electrostatic circuits; wave analysis. I, (4). *Prerequisite:* Physics 1b, 3b; Mathematics 9; registration in Mathematics 9a or 16; registration in Electrical Engineering 75.
26. **DIRECT CURRENT APPARATUS.**—Theory and characteristics of direct current apparatus. II, (3). *Prerequisite:* Electrical Engineering 25; Mathematics 9a; registration in Electrical Engineering 76.
35. **ALTERNATING CURRENT APPARATUS.**—Transformers and generators. I, (4). *Prerequisite:* Electrical Engineering 26, 76; registration in Electrical Engineering 85.
36. **ALTERNATING CURRENT APPARATUS.**—Synchronous, induction, and commutator motors; rotary converters, distributed inductance and capacity, transient phenomena. II, (4). *Prerequisite:* Electrical Engineering 35; registration in Electrical Engineering 86.
41. **TRANSIT ENGINEERING PRINCIPLES.**—Railway mechanics, electric railway power equipment and control. I, (5). *Prerequisite:* Electrical Engineering 25 and 26.
42. **TRANSIT ENGINEERING PRACTICE.**—Electric cars, locomotives, electrification systems, traffic studies. II, (4). *Prerequisite:* Electrical Engineering 41.
44. **TRANSIT ENGINEERING LABORATORY AND DESIGN.**—Laboratory testing of electrical railway equipment, design of an electric rail line, choice of equipment. II, (3). *Prerequisite:* Registration in Electrical Engineering 42.
46. **TRANSIT ENGINEERING.**—Electric railway theory and practice, for students of other engineering departments. II, (3). *Prerequisite:* Electrical Engineering 11 and 61, or Electrical Engineering 25 and 75.
48. **FUNDAMENTALS OF TELEPHONE TRANSMISSION.**—Fundamentals of telephone networks and transmission lines, loading, filters, reflections, inductive interference, and superimposed circuits. II, (3). *Prerequisite:* Senior standing in Electrical Engineering, or consent of instructor.
50. **INTRODUCTION TO APPLIED ELECTRONICS.**—Fundamental principles of the design, operation, and application of electron devices. II, (2). *Prerequisite:* Electrical Engineering 25.
51. **RADIO COMMUNICATION APPARATUS.**—Fundamentals of circuits of and phenomena in radio communication apparatus. Measurement of radio frequency circuit parameters, wave propagation, performance of transmitters and receivers. I, (3). *Prerequisite:* Electrical Engineering 25, 50, or equivalent.
52. **RADIO ENGINEERING DESIGN.**—Fundamentals of design of radio transmitters, transmission lines, antennas, and receivers. Laboratory measurements associated with design. II, (3). *Prerequisite:* Electrical Engineering 51, or equivalent.
54. **VACUUM TUBES AND CONTROL DEVICES.**—Theory, characteristics, and application of the high vacuum tubes, amplifiers, and control devices. I, (3). *Prerequisite:* Electrical Engineering 25, 50.
55. **ELECTRICAL DESIGN.**—Electromagnets and dynamos, direct and alternating; transformers. I, (2). *Prerequisite:* Electrical Engineering 26; registration in Electrical Engineering 35.
56. **ECONOMICAL DESIGN OF ELECTRICAL SYSTEMS.**—Power plants, distribution, etc. II, (4). *Prerequisite:* Electrical Engineering 35.
57. **ELECTRICAL ENERGY MEASUREMENTS AND SYSTEM PROTECTION.**—Theory and application of power and energy measuring equipment. Protection of transmission and distribution systems. II, (3). *Prerequisite:* Senior standing in electrical engineering, or consent of instructor.
58. **POWER TRANSMISSION AND DISTRIBUTION CIRCUITS.**—Transient behavior of lumped constant circuits by differential equation methods and by Heavisides expansion theorem; development general network theorems; steady state solution with distributed constants; system stability analysis. I, (3). *Prerequisite:* Electrical Engineering 25.

59. ELECTRON TUBES.—Theory, characteristics, and applications of glow and arc discharge tubes, photocells, electronic control devices, rectifiers, oscillators, and inverters. II, (3). *Prerequisite:* Electrical Engineering 54, or consent of instructor.
61. DIRECT AND ALTERNATING CURRENT LABORATORY.—Circuits. For students in agricultural, chemical, general, mechanical, and railway engineering, and industrial administration. I, (1). *Prerequisite:* Registration in Electrical Engineering 11.
62. DIRECT AND ALTERNATING CURRENT LABORATORY.—Machines. For students in agricultural, chemical, general, mechanical, and railway engineering, and industrial administration. II, (1). *Prerequisite:* Electrical Engineering 11, 61; registration in Electrical Engineering 12.
64. DIRECT AND ALTERNATING CIRCUITS AND MACHINE LABORATORY.—To accompany Electrical Engineering 4. For students in agricultural, civil, mining, and ceramic engineering, and ceramics. I and II, (1). *Prerequisite:* Registration in Electrical Engineering 4.
65. ELECTRICAL EQUIPMENT LABORATORY.—To accompany Electrical Engineering 5. For students in mining and ceramic engineering. II, (1). *Prerequisite:* Registration in Electrical Engineering 5.
- 71-72. ELECTRICAL ENGINEERING PROBLEMS.—Special problems approved by the department. (a) Advanced Electronics; (b) Electric Meters, Relays, and Protective Devices; (c) Advanced Illumination; (d) Special Investigations. I and II, (1 to 3). *Prerequisite:* Approval of written application to department.
75. ELECTRICAL ENGINEERING LABORATORY.—Direct and alternating current circuits and instruments. I, (2). *Prerequisite:* Registration in Electrical Engineering 25.
76. ELECTRICAL ENGINEERING LABORATORY.—Operation and testing of direct current machines. II, (3). *Prerequisite:* Electrical Engineering 25, 75; registration in Electrical Engineering 26.
84. VACUUM TUBE LABORATORY.—Experimental study of the characteristics and applications of high vacuum tubes. I, (1). *Prerequisite:* Registration in Electrical Engineering 54, or consent of instructor.
85. ELECTRICAL ENGINEERING LABORATORY.—Advanced alternating current laboratory. I, (2). *Prerequisite:* Electrical Engineering 76; registration in Electrical Engineering 35.
86. ELECTRICAL ENGINEERING LABORATORY.—Advanced alternating current laboratory. II, (2). *Prerequisite:* Electrical Engineering 85; registration in Electrical Engineering 36.
89. ELECTRON TUBE LABORATORY.—Experimental study of glow and arc discharge tubes and photocells and their applications to power control. II, (1). *Prerequisite:* Registration in Electrical Engineering 59, or consent of instructor.
90. BUILDING LIGHTING.—Electric lamps and other illuminants and their effective use. I and II, (1). Not open to students with credit in Electrical Engineering 14. *Prerequisite:* Junior standing.
92. BUILDING WIRING.—Interior wiring design, underwriter's rules, distribution and fusing. I, (1). Not open to students with credit in Electrical Engineering 14. *Prerequisite:* Junior standing.
- 95-96. SEMINAR.—Papers and discussion of current engineering topics. I and II, (1). *Prerequisite:* Senior standing in electrical engineering.
- 97-98. THESIS.—First semester, preliminary reading and investigation; second semester, completion. Continuous through I and II, (0 to 3).
99. INSPECTION TRIP.—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—The prerequisite for graduate work in electrical engineering is the equivalent of the undergraduate courses required for the degree of Bachelor of Science in electrical engineering in the branches of the subject in which registration is desired. Graduate students who wish to take a minor in electrical engineering must have had differential and integral calculus and one year's work in college physics. Courses offered to junior and senior students in electrical engineering are open for minor credit to graduate students who have the necessary prerequisites.

101. ADVANCED COURSES IN ALTERNATING CURRENTS.—I and II, ($\frac{1}{2}$ to 2 units).
 - (a) GRADUATE SEMINAR.—Required. (No credit). Professor PAINE.
 - (b) CIRCUIT TRANSIENTS.—Professors KNIGHT and REICH.
 - (c) MACHINE TRANSIENTS.—Associate Professor KEENER.
 - (d) SYMMETRICAL COMPONENTS.—Professor KRAHENBUEHL, Assistant Professor FAUCETT.
102. ELECTRIC WAVES, OSCILLATIONS, AND TRANSIENTS.—I and II, ($\frac{1}{2}$ to 2 units).
 - (a) THEORY OF ENERGY RADIATION.—Professor BROWN.
 - (b) PRINCIPLES OF TELEVISION ENGINEERING.—Professor BROWN.
103. ELECTRIC DESIGN.—I and II, (1 to 3 units).
 - (a) POWER PLANT DESIGN.—Professor PAINE.
 - (b) MACHINE DESIGN.—Professor PAINE.
 - (c) ILLUMINATION PRACTICE AND DESIGN.—Professor KRAHENBUEHL.
104. VACUUM TUBES AND ELECTRONIC CONTROL.—I and II, (1 unit).
 - (a) THEORETICAL ELECTRONICS.—Professor REICH.
 - (b) VACUUM TUBES AND AMPLIFIERS.—Professor REICH.
 - (c) PHOTOELECTRIC CELLS, GASEOUS CONTROL TUBES, AND INVERTERS.—Professor REICH.
105. ELECTRICAL ENGINEERING RESEARCH.—I and II, (1 to 3 units). Professors PAINE, TYKOCINER, KNIGHT, REICH, BROWN, and KRAHENBUEHL, Associate Professor KEENER, Assistant Professor FAUCETT.

ENGINEERING

Professors: CASBERG, CRANDELL, DRAFFIN, KING, PICKELS, YOUNG.
Associates: L. L. SMITH.

Courses for Undergraduates

NOTE:—Each of the following courses may be used as an approved or non-technical elective in all engineering curricula.

10. ENGINEERING ECONOMICS.—Evolution and growth of industry; basic industrial principles; ownership and securities; standardization; valuation and depreciation; comparisons and selections of engineering projects. I and II, (3). *Prerequisite*: Sophomore standing in engineering.
20. HISTORY OF ENGINEERING.—Important elements in the growth of the art and science of engineering from ancient times to the present. Lives of some of the men who have been leaders. Effect of engineering on social conditions of various periods. I and II, (2). *Prerequisite*: Junior standing in engineering.
39. INDUSTRIAL RELATIONS.—History of the development of industry; the factory system; manufacturers' organizations; labor organizations; works management; wage systems; personnel problems; labor legislation. I and II, (3). *Prerequisite*: Junior standing.
40. TRANSPORTATION DEVELOPMENT.—Transportation systems; history and technical development of city transit systems, and of rail, highway, waterway, and air transport; organization and interrelation. I and II, (3). *Prerequisite*: Sophomore standing.
41. TRANSPORTATION PROBLEMS.—Continuation of Engineering 40. Regulation of transportation systems, technical, operating, and financial, by government bodies; government vs. private ownership and operation; technical and economic problems of transport systems. I, (3). *Prerequisite*: Engineering 40, or senior standing in engineering.
92. ENGINEERING LAW.—Contracts, evidence, torts, equity, real property, corporations, agency, sales, negotiable instruments, water rights, patent rights, special assessments, contract letting, general conditions. I and II, (3). *Prerequisite*: Senior standing in engineering or architecture.

GENERAL ENGINEERING DRAWING

Professors: JORDAN (Head of the Department), HOELSCHER.

Associate Professors: SPRINGER.

Assistant Professors: PORTER, JORGENSEN, HALL.

Associates: CROSSMAN, WALKER, LENDRUM.

Instructors: FINK, PIERCE, RITCHEY, LARSON, PEARSON.

Courses for Undergraduates

1. ELEMENTS OF DRAWING.—Lettering; orthographic projection; working drawings; chart and diagram drawing; isometric and oblique drawing; freehand sketching; tracings; methods of reproducing drawings. I and II, (4). Seniors receive only three hours credit. *Prerequisite:* Plane geometry.
2. DESCRIPTIVE GEOMETRY.—Theory of projections; solution of theoretical and practical problems involving size, shape, and relative position of common geometrical magnitudes such as points, lines, planes, curved surfaces, and solids; intersections, developments, shades and shadows, perspective drawing, etc. I and II, (4). *Prerequisite:* Plane and solid geometry.
4. ADVANCED DRAWING.—Review of orthographic projection and working drawings; isometric, oblique, perspective, chart and diagram, topographical, architectural, and structural drawing. I and II, (4). *Prerequisite:* Three years of high school drawing, or the equivalent to be determined by the department.
6. ELEMENTS OF DRAWING.—Same topics covered as in General Engineering Drawing 1 plus piping and perspective drawing. For students in chemical engineering. I and II, (3). *Prerequisite:* Plane geometry.
7. ARCHITECTURAL PROJECTIONS.—Instrumentation; lettering; projection; intersections; conventions; shades and shadows; oblique, isometric, and perspective drawing. I, (2). *Prerequisite:* Plane and solid geometry.
8. ARCHITECTURAL PROJECTIONS (CONTINUED).—Shades and shadows; oblique, isometric, and perspective drawing; developments. II, (2). *Prerequisite:* General Engineering Drawing 7.
10. PICTORIAL DRAWING.—Review of perspective and of shades and shadows; rendering of drawings in pencil, pastel, and water colors; elementary design and study of proportion. An approved elective in all engineering curricula. I and II, (3 or 4). *Prerequisite:* General Engineering Drawing 2.
12. GRAPHICAL CALCULATIONS.—Construction and uses of nomographs, coordinate papers (principally logarithmic and semi-logarithmic), various types of slide rules, and mechanical calculating devices; other methods of engineering calculations. An approved elective in all curricula of the college. I and II, (1). *Prerequisite:* General Engineering Drawing 1; Mathematics 6a.

MECHANICAL ENGINEERING

Professors: LEUTWILER (Head of the Department), SCHMIDT (Emeritus), KRATZ, HAM, POLSON, CASBERG, MACINTIRE, SEVERNS, ESPY, YOUNG.

Associate Professors: RIDDELL, RYAN.

Assistant Professors: MOHN, THOMAS, LARSON, HERSHEY, FELLOWS, SCHUBERT.

Associates: HALL (Emeritus), LANHAM (Emeritus), WOODDELL, STARR, WILLIAMS, TRIGGER.

Instructors: WRIGHT, BROGHAMER, MILES, COVAN, COMPTON, GRACE, BOLT, GOLLIA, LUKE, SEYFARTH, KRANS.

Assistants: DERROUGH.

Courses for Undergraduates

1. STEAM, AIR, AND GAS MACHINERY.—Theory, construction, operating, characteristics of boilers, prime movers, air compressors, and auxiliaries. For civil engineering students. I and II, (3). *Prerequisite:* Mathematics 9; Physics 1 and 3.
2. STEAM ENGINEERING.—Thermodynamic properties of working mediums, transformation of heat to work, theoretical and practical limitations; the second law, absolute temperature, available energy; power cycles, ideal and practical; energy

- equations of steady flow; power equipment and auxiliaries. For chemical engineering students. II, (3). *Prerequisite:* Mathematics 9 or 8b; Physics 1 and 3.
3. POWER PLANT ENGINEERING.—Steam generators, prime movers, and auxiliaries, for central stations. For electrical and general engineering students. I, (3). *Prerequisite:* Mechanical Engineering 10.
5. LOCOMOTIVES.—Steam and other motive power; mechanics; thermal analysis. I, (3). *Prerequisite:* T.A.M. 1; registration in Mechanical Engineering 13 and T.A.M. 2.
6. POWER PLANT EQUIPMENT.—Introduction to the functions and characteristics of equipment, including steam generators, prime movers, condensers, pumps, air compressors, fans, chimneys, feed water treatment, and auxiliaries. For mechanical engineering students. II, (4). *Prerequisite:* Registration in Mechanical Engineering 14.
7. INTERNAL COMBUSTION ENGINES.—Theory, performance, and general characteristics. I and II, (3). *Prerequisite:* Mechanical Engineering 6 or 3.
8. RAILWAY OPERATION.—Train resistance; mechanics of train movement; locomotive economy and performance; shops and terminal facilities. II, (3). *Prerequisite:* Mechanical Engineering 5.
10. THERMODYNAMICS.—Transformation of heat to work, theoretical and practical limitations, absolute scale of temperature and its significance, thermodynamic properties of working media, energy equation of steady flow, analysis of ideal power and refrigeration cycles. For electrical or general engineering students. I and II, (3). *Prerequisite:* Mathematics 9; Physics 1 and 3.
13. THERMODYNAMICS.—Transformations of energy, theoretical limitations; second law, absolute temperature, entropy and available energy; properties of gases, liquids, vapors, and vapor mixtures. I, (3). *Prerequisite:* Mathematics 9; Physics I and 3.
14. THERMODYNAMICS.—Energy relations of one-dimensional steady flow of compressible fluids applied to the de Laval nozzle, simple orifice, and long pipe; simple single-stage impulse turbine; ideal power cycles; thermodynamics and processes of moist air; and other applications. II, (3). *Prerequisite:* Mechanical Engineering 13.
15. ENGINEERING THERMODYNAMICS.—Application of principles of thermodynamics to selected problems of power production, heat transfer, fluid flow of a compressible medium, cycle analysis. II, (3). *Prerequisite:* Mechanical Engineering 14.
17. REFRIGERATION ENGINEERING.—Mechanical cooling in industrial processes. I and II, (3). *Prerequisite:* Mechanical Engineering 14.
21. MECHANICAL EQUIPMENT OF BUILDINGS.—Laboratory tests of steam engines, turbines, pumps, hot-blast heaters, fans, air-washers, heating boilers, and air compressors. I, (1). *Prerequisite:* Senior standing; registration in Mechanical Engineering 23.
23. MECHANICAL EQUIPMENT OF BUILDINGS.—Small power plants, direct and indirect heating, ventilation, and air conditioning. I, (4). *Prerequisite:* Senior standing; registration in Mechanical Engineering 21.
25. HEATING AND VENTILATION FOR ARCHITECTS.—Direct and indirect heating, ventilation and air analysis, air conditioning. I, (2). *Prerequisite:* Senior standing.
28. HEATING, VENTILATING, AND AIR CONDITIONING.—Steam boilers and water heaters, direct and indirect heating, gravity systems, district heating, ventilation and air analysis, air conditioning. II, (4). *Prerequisite:* Mechanical Engineering 16 and 65.
31. MECHANICS OF MACHINERY.—Cams, gears; graphical construction; kinetics; balancing; critical speeds; force and mass reduction. I, (5). *Prerequisite:* Registration in Theoretical and Applied Mechanics 2.
33. AERONAUTICAL ENGINEERING.—Aerodynamic principles in airplane design. I, (3). *Prerequisite:* Senior standing.
34. AERONAUTICAL ENGINEERING.—Loads and stresses, materials and methods of construction. II, (3). *Prerequisite:* Mechanical Engineering 33.
35. PETROLEUM PRODUCTION ENGINEERING.—Development; properties of petroleum, petroleum reservoirs, exploration methods, field development, drilling, oil field hydrology, oil well completion. I, (3). *Prerequisite:* Senior standing in mechanical engineering, or consent of instructor.

36. PETROLEUM PRODUCTION ENGINEERING.—Production methods: reservoir drainage, controlled flowing, gas lift, pumping, repressuring, water drive, natural gasoline, storage, transportation. II, (3). *Prerequisite:* Mechanical Engineering 35, or consent of instructor.
40. MECHANICAL ENGINEERING DESIGN.—Design of machinery subjected to heavy and variable stresses. II, (3). *Prerequisite:* Theoretical and Applied Mechanics 3 and 63; Mechanical Engineering 31.
41. MECHANICAL ENGINEERING DESIGN.—Continuation of course 40. I, (4). *Prerequisite:* Mechanical Engineering 40.
52. POWER PLANT DESIGN.—Study and design of some form of modern steam power plant. II, (3). *Prerequisite:* Mechanical Engineering 65.
54. LOCOMOTIVE AND CAR DESIGN.—Motive power and rolling stock selection; standards and proportions. II, (3). *Prerequisite:* Senior standing in engineering; registration in Mechanical Engineering 8.
61. MECHANICAL ENGINEERING LABORATORY.—Tests of prime movers and auxiliaries. For chemical and electrical engineering students. I and II, (2). *Prerequisite:* Mechanical Engineering 1, 2, or 3, or concurrent registration in Mechanical Engineering 3 for electrical and railway electrical engineers.
62. MECHANICAL ENGINEERING LABORATORY.—Steam boilers and auxiliaries, steam prime movers, pumps, condensers, fans, air compressors and internal combustion engines. Lectures, recitations, and laboratory. II, (3). Students who have credit in Mechanical Engineering 1, 2, or 3 may register for one hour of laboratory work only. *Prerequisite:* Junior standing.
64. MECHANICAL ENGINEERING LABORATORY.—Instruments and tests of steam prime movers, pumps, fans, internal combustion engines, and flow of compressible media. Engineering reports. II, (3). *Prerequisite:* Registration in Mechanical Engineering 6 and 14; for general engineering students, Mechanical Engineering 3.
65. MECHANICAL ENGINEERING LABORATORY.—Tests of air conditioning equipment, reciprocating steam pumps, air compressors, and other power and mechanical equipment selected by the students. Engineering reports. I, (3). *Prerequisite:* Mechanical Engineering 64.
84. WELDING ENGINEERING.—Fundamentals of welding processes; metallography of welds; design, stress distribution and strength of welds; application of welding to the design of machines and structures; selection of materials, and equipment; fabrication, supervision, and inspection. I and II, (3). *Prerequisite:* Senior standing in engineering; consent of instructor.
85. PATTERN AND FOUNDRY LABORATORY.—Design of wood and metal patterns; metallurgy of gray iron; floor, bench, and machine molding; core making; brass furnace and cupola practice; sand testing. I and II, (3). *Prerequisite:* Sophomore standing; General Engineering Drawing 1 or 4.
87. MACHINE TOOL LABORATORY.—Machine tools; fixtures, jigs, and tools for producing interchangeable parts. I and II, (3). *Prerequisite:* Sophomore standing.
88. MACHINE TOOL LABORATORY.—Experiments on machine tool performance, tool and fixture design, shop management and production problems. II, (3). *Prerequisite:* Mechanical Engineering 87.
89. HEAT TREATMENT OF METALS.—Annealing, hardening, tempering, and carburizing carbon and alloy steels; their microstructures; heat treatment of nonferrous metals. I and II, (3). *Prerequisite:* Senior standing in mechanical or railway mechanical engineering.
- 97-98. THESIS.—Investigation of special subjects and preparation of thesis embodying review of the literature, discussion of results. Continuous through I and II, (0 to 3). *Prerequisite:* Senior standing.
99. INSPECTION TRIP.—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—The prerequisite for graduate work in mechanical engineering is the equivalent of the undergraduate course required for a bachelor's degree in mechanical engineering in the branch of the subject in which registration is desired.

107. THERMODYNAMICS.—Mathematics of thermodynamics; application of thermodynamics to solution of physical and engineering problems. I and II, (1 unit).

108. FLOW OF FLUIDS AND HEAT TRANSFER.—Application of dimensional analysis and other rational formulas. Special problems. I and II, (1 unit). Professor MACINTIRE.
109. MECHANICAL ENGINEERING DESIGN.—Machine design, power plant design, dynamics of machinery. I and II, (1 unit). Professors LEUTWILER and HAM.
110. ADVANCED HEATING, VENTILATING, AND AIR CONDITIONING.—Applications of various systems, notable developments, results of research. Individual problems. I and II, (1 unit). Professor SEVERNS.
112. LABORATORY INVESTIGATIONS.—Special problems in: (a) combustion; (b) steam; (c) gas and oil engineering; (d) heating, ventilation, and air conditioning; (e) refrigeration; (f) flow of fluids; (g) heat transfer; (h) mechanical transmission of power; (i) railway equipment. I and II, (1½ units). Professors POLSON, KRATZ, HAM, MACINTIRE, SEVERNS, and YOUNG.
117. ADVANCED REFRIGERATING ENGINEERING.—Advanced theory and special cycles; design of comfort cooling and other special installations. I and II, (1 unit). Professor MACINTIRE.
120. LOCOMOTIVE DESIGN.—Economic and legal considerations; specifications; weight and distribution; relation of steam pressure, compounding, and superheat to performance and economy. I and II, (1 unit). Professor YOUNG.
121. LOCOMOTIVE OPERATION.—Train resistance and locomotive tractive force; tonnage ratings. I and II, (1 unit). Professor YOUNG.

MINING AND METALLURGICAL ENGINEERING

Assistant Professors: WALKER (Acting Head of the Department),
NICHOLSON, BRUCKNER, WEYSER.
Instructors: ECKEL, RICKETTS, SNYDER.

MINING

Courses for Undergraduates

1. ELEMENTS OF MINING.—Explosives, drilling, blasting, coal-cutting, shaft-sinking, tunneling. For mining students only. I, (4). *Prerequisite:* Physics 1b, 3b; Geology 43; Theoretical and Applied Mechanics 1.
2. MINING PRINCIPLES.—Terminology; explosives and blasting, well and rock drilling, shaft-sinking and tunneling; methods of working and timbering flat and inclined deposits. For students in curricula other than mining. II, (3). *Prerequisite:* One year of college chemistry and physics.
4. MINING METHODS.—Methods of working bedded, vein, and placer deposits. II, (4). *Prerequisite:* Mining 1.
6. MECHANICAL ENGINEERING OF MINES.—Hoisting: ropes, cages and skips, hoisting engines; haulage: cars, locomotives, track; mine drainage and pumping. II, (3). *Prerequisite:* Mining 4; Electrical Engineering 4 and 64; Mechanical Engineering 62; Theoretical and Applied Mechanics 2.
8. MINE ADMINISTRATION.—Mining law; mine management; trade agreements; wage systems; personnel administration. I, (3). *Prerequisite:* Mining 4; Accountancy 12.
9. PREPARATION OF COAL AND ORE.—History, processes, machines; coal preparation; breaking, sizing and concentration of ores; laboratory work in coal preparation and ore dressing. I, (3). *Prerequisite:* Chemistry 22; Physics 1b, 3b; Geology 20, or equivalent.
12. MINING GEOLOGY.—Structural geology and its relation to mining; geophysical prospecting; surface and underground geologic mapping; mine geologic records; mine models. II, (3). *Prerequisite:* Mining 4; Geology 20 and 43.
15. MINE VENTILATION.—Mine gases and safety lamps; ventilation of mines; mine fires and explosions. II, (2). *Prerequisite:* Mining 4.
20. MINE VENTILATION LABORATORY.—Laboratory work to accompany Mining 15. II, (2). *Prerequisite:* Registration in Mining 15.
21. EXAMINATION, VALUATION, AND REPORTS.—Prospecting mineral deposits; methods of examining, valuing, and reporting on mining properties. II, (3). *Prerequisite:* Mining 4.

41. MINING DESIGN.—Application of engineering principles to the design of portions of a mine plant; estimates of quantities and costs. I, (3). *Prerequisite:* Senior standing in mining engineering.
42. MINING DESIGN.—Continuation of Mining 41. II, (2). *Prerequisite:* Mining 41.
62. MINE SURVEYING.—Mine surveying; mineral land surveying; field astronomy. A surveying trip is made to neighboring mines; estimated expense, \$10. I, (3). *Prerequisite:* Civil Engineering 15, or equivalent.
64. COAL AND ORE PREPARATION LABORATORY.—Crushing, dry preparation, and washing of coals; wet and dry concentration of ores; sampling; analysis of raw and finished products. II, (2). *Prerequisite:* Mining 9.
90. MINING AND METALLURGICAL REPORTS.—Review of mining and metallurgical literature; reports; technical writing. II, (1). *Prerequisite:* Senior standing in mining or metallurgical engineering.
- 97-98. THESIS.—Continuous through I and II, (1 to 3). *Prerequisite:* Senior standing and approval of head of department.
99. MINING INSPECTION TRIP.—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—The prerequisite for graduate work with mining engineering as a major is the equivalent of the undergraduate courses required for a bachelor's degree in mining engineering. Courses for advanced undergraduates are open for minor credit to students whose major is in other departments who have adequate preparation in physics, mathematics, and mechanics.

101. ADVANCED MINING PRACTICE.—Comparison of foreign and American methods; utilization and storage of coal; transportation and markets. I and II, (1 unit). Assistant Professor NICHOLSON.
102. ADVANCED PREPARATION OF COAL AND ORES.—Recent advances in concentration and beneficiation of coal and minerals. I and II, (1 unit). Assistant Professor NICHOLSON.
104. MINING REPORTS.—Classification of coal and ore lands; conservation of mineral resources; mine examinations and appraisal reports. I and II, (1 unit). Assistant Professor NICHOLSON.
105. WELFARE WORK AND EDUCATION AMONG MINE EMPLOYEES.—Organization and operation of mining institutes, night classes, welfare, mine rescue, and first-aid work. I and II, (1 unit). Assistant Professor NICHOLSON.
106. ADVANCED COAL AND ORE PLANT DESIGN.—II, (1 unit). Assistant Professor NICHOLSON.

METALLURGY

Courses for Undergraduates

1. ELEMENTS OF METALLURGY.—For students in curricula other than metallurgical engineering. Production of refined ferrous and non-ferrous metals from their ores; properties of metals and alloys as related to structure and treatment; constitutional diagrams; casting, shaping, and welding. I, (3). *Prerequisite:* Chemistry 4, 5, or 6; Physics 1b, 3b; junior standing.
2. PRINCIPLES OF METALLURGY.—Ores, fluxes, slags, metallurgical processes, types of furnaces, fuels. I, (3). *Prerequisite:* Registration in Ceramic Engineering 21 and Chemistry 48a.
3. FIRE ASSAYING.—Fire assaying of gold, silver, lead, and copper ores, mattes, and bullion; fluxes, slags, and charge calculations. I, (2). *Prerequisite:* Chemistry 22; Geology 20.
4. PHYSICAL METALLURGY.—Properties of metals and alloys as related to structure and treatment; constitutional diagrams; casting, shaping, and welding; problems. I, (3). *Prerequisite:* Credit or registration in Geology 20 and Metallurgy 2.
5. FERROUS METALLURGY.—Production of pig iron, wrought iron, steel; blast furnace, Bessemer, open hearth, and electric furnaces; casting, shaping, heat treatment; problems. II, (3). *Prerequisite:* Registration or credit in Metallurgy 6.
6. METALLURGICAL CALCULATIONS.—Fundamental calculations relating to processes, heat balances, and the thermochemistry of metallurgical reactions. II, (2). *Prerequisite:* Metallurgy 4; Chemistry 48a.

7. FERROUS METALLOGRAPHY.—Internal structure, constitution, treatment, and properties of pure iron, of steel with various amounts of carbon, of alloy steels and cast iron. I, (3). *Prerequisite:* Metallurgy 4; Theoretical and Applied Mechanics 3 and 63.
8. FERROUS METALLOGRAPHY LABORATORY.—Heat treatment, thermal analysis; preparation of specimens, use of microscope, photomicrography; interpretation of structure of alloys discussed in Metallurgy 7. I, (2). *Prerequisite:* Registration in Metallurgy 7.
9. NON-FERROUS METALLURGY.—The metallurgy of the non-ferrous metals—copper, lead, zinc, aluminum, gold, silver, etc.; principles, processes, problems. I, (3). *Prerequisite:* Metallurgy 6; Mining 9.
10. NON-FERROUS METALLOGRAPHY.—Internal structure, constitution, treatment, and properties of non-ferrous metals and alloys. Laboratory work in preparation of alloys; heat treatment, microscopic examination, photomicrography, and interpretation of structure. II, (3). *Prerequisite:* Metallurgy 7, 8, 9.
11. ELECTROMETALLURGY.—Theory and application of electrical energy to metallurgy. Laboratory work in electro-refining, electric furnace operation and construction, electro-plating and welding. II, (3). *Prerequisite:* Metallurgy 9.
12. METALLOGRAPHY.—For students in curricula other than metallurgical engineering. Internal structure, constitution, treatment, and properties of metals and alloys. Laboratory work in preparation of alloys; cooling curves; heat treatment, microscopic examination, photomicrography, and interpretation of structure. II, (3). *Prerequisite:* Metallurgy 1.
13. UTILIZATION OF FUELS.—The manufacture, handling, and utilization of fuels in mining and metallurgical practice; problems in combustion; laboratory work in fuel analysis. II, (3). *Prerequisite:* Chemistry 22; junior standing in engineering.
41. METALLURGICAL DESIGN.—Application of engineering principles to the design of portions of a metallurgical plant; estimates of quantities and costs. I, (3). *Prerequisite:* Senior standing in metallurgical engineering.
42. METALLURGICAL DESIGN.—Continuation of Metallurgy 41. II, (2). *Prerequisite:* Metallurgy 41.
- 97-98. THESIS.—Continuous through I and II, (1 to 3). *Prerequisite:* Senior standing and approval of head of department. Members of the department.
99. INSPECTION TRIP.—I, (no credit). *Prerequisite:* Senior standing.

Courses for Graduates

NOTE:—The prerequisite for graduate work with metallurgical engineering as a major is the equivalent of the undergraduate courses required for a bachelor's degree in metallurgical engineering. Courses for advanced undergraduates are open for minor credit to students in other departments who have adequate preparation in physics, chemistry, and mechanics.

101. RESEARCH IN METALLURGY.—I and II, (1 to 2 units). Assistant Professors WALKER and BRUCKNER.
102. ADVANCED PHYSICAL METALLURGY.—II, (1 unit). Assistant Professor WALKER.
103. ADVANCED METALLOGRAPHY: FERROUS ALLOYS.—II, (1 unit). Assistant Professor WALKER.
104. ADVANCED METALLOGRAPHY: NON-FERROUS ALLOYS.—I, (1 unit). Assistant Professor WALKER.

PHYSICS

Professors: LOOMIS (Head of the Department), CARMAN (Emeritus), KNIPP (Emeritus), WATSON (Emeritus), KRUGER.

Associate Professors: SCHULZ (Emeritus), WILLIAMS, PATON, BARTLETT, ALMY, MOTT-SMITH.

Assistant Professors: GOLDBABER, RICHARDSON, SERBER, HAWORTH.

Associates: MANLEY, JORDAN, LYMAN, BOLT, RAMSEY.

Instructors: KERST, PHILLIPS, DANCOFF, KANNER.

Assistants: HALES, PARKER, GAMERTSFELDER, GOOD, KORTY, McCLELLAN, COGGESHALL, MARTIN, BERGER, BALDWIN, KLAIBER, KODIS, KRUGER, LEE, CLARK, F. N. GILLETTE, P. R. GILLETTE, WELTON, OGLE, LEITER, TALLMADGE, TAYLOR, YOUNKER, ADAMS.

Introductory Courses for Undergraduates

- 1a. GENERAL PHYSICS (MECHANICS, SOUND, AND HEAT).—Lectures with demonstrations and recitations. For students in engineering, mathematics, physics, and chemistry. I and II, (4). *Prerequisite*: Mathematics 2 and 4; registration in Physics 3a.
- 1b. GENERAL PHYSICS (ELECTRICITY AND MAGNETISM, AND LIGHT).—I and II, (4). *Prerequisite*: Physics 1a; registration in Physics 3b.
- 3a. GENERAL PHYSICS LABORATORY.—To accompany Physics 1a. I and II, (1). *Prerequisite*: Physics 1a, or registration therein.
- 3b. GENERAL PHYSICS LABORATORY.—To accompany Physics 1b. I and II, (1). *Prerequisite*: Physics 1b, or registration therein.
- 7a. GENERAL PHYSICS (MECHANICS, SOUND, AND HEAT).—Lectures with demonstrations and recitations. For students in arts and sciences, and architecture. I, (4). *Prerequisite*: Trigonometry; registration in Physics 8a.
- 7b. GENERAL PHYSICS (LIGHT, ELECTRICITY, AND MAGNETISM).—II, (4). *Prerequisite*: Physics 7a; registration in Physics 8b.
- 8a. GENERAL PHYSICS LABORATORY.—To accompany Physics 7a. I, (1). *Prerequisite*: Physics 7a, or registration therein.
- 8b. GENERAL PHYSICS LABORATORY.—To accompany Physics 7b. II, (1). *Prerequisite*: Physics 7b, or registration therein.

Courses for Advanced Undergraduates and Graduates

15. ELEMENTARY ELECTRICITY AND MAGNETISM.—For students in non-technical courses who wish a knowledge of electricity and magnetism beyond the course in general physics. Lectures and laboratory. II, (3). *Prerequisite*: General physics.
16. ELEMENTARY HEAT.—Temperature measurement, pyrometry, radiation, heat flow, thermal stresses, calorimetry, and elementary thermodynamics. I, (3). *Prerequisite*: General physics.
17. ELEMENTARY LIGHT.—For students in non-technical courses who wish a knowledge of light beyond the course in general physics. Lectures and laboratory. I, (3). *Prerequisite*: General physics.
- 20a. THEORETICAL MECHANICS.—Statics; dynamics of particles. I, (3). *Prerequisite*: General physics and calculus.
- 20b. THEORETICAL MECHANICS (CONTINUED).—Dynamics of rigid bodies; generalized coordinates and LaGrange's equations; vibrations of systems of particles, with electrical analogies. II, (3). *Prerequisite*: Physics 20a.
23. SOUND.—Wave motion; origin, propagation, velocity, interference, and diffraction of sound; vibrations of strings and organ pipes; music and speech. Lectures and recitations. I, (3). *Prerequisite*: General physics.
25. ARCHITECTURAL ACOUSTICS.—Acoustics of buildings, including acoustic correction of auditoriums and offices, sound-proofing of rooms, and reduction of vibrations set up by machines. II, (2). *Prerequisite*: General physics.
30. INTRODUCTION TO THEORETICAL ELECTRICITY.—Laws of electrostatics, magnetism, electric and magnetic circuits, induced currents, alternating currents, oscillations, and thermionic tubes. Lectures and problems. I, (3). *Prerequisite*: General physics and calculus.
- 40a. ELECTRICITY AND MAGNETISM.—Electric field, theory of dielectrics, solutions of poisson's and Laplace's equations, magnetostatics, steady current theory; fundamental electrostatic, resistance bridge measurements, and potentiometer experiments. I, (3). *Prerequisite*: General physics and calculus.
- 40b. ELECTRICITY AND MAGNETISM.—Ampere's law and applications, motion of charged particles in electric and magnetic fields, electromagnetic induction, alternating current theory, the electromagnetic field. Laboratory experiments in A.C. bridge measurements of capacitance, inductance, vacuum tubes, and magnetism. II, (3). *Prerequisite*: Physics 40a.
44. ELECTRIC AND MAGNETIC MEASUREMENTS.—Resistances, galvanometers, capacitances, potentiometers, thermocouples, inductances, magnetization, high frequency measurements. I and II, (3). *Prerequisite*: General physics and calculus.
46. VACUUM TUBES.—II, (3). *Prerequisite*: Physics 40.
51. PRACTICAL OPTICS.—Lectures and laboratory dealing with the design and use of optical instruments. II, (3). *Prerequisite*: Physics 17 or 71a.

60. HEAT.—Heat phenomena, mechanical theory of heat, thermodynamics. Lectures and recitations. II, (3). *Prerequisite:* General physics and calculus.
61. HEAT LABORATORY.—To accompany Physics 61. II, (1). *Prerequisite:* Registration in Physics 60.
62. KINETIC THEORY OF HEAT AND RADIATION.—II, (3). *Prerequisite:* General physics and calculus.
- 71a. LIGHT.—Geometrical and physical optics; the electro-magnetic theory of light. Lectures and recitations. I, (2). *Prerequisite:* General physics and calculus.
- 71b. LIGHT (CONTINUED).—II, (2). *Prerequisite:* Physics 71a.
- 72a. LIGHT LABORATORY.—Lenses and prisms, diffraction, interference, polarization. I, (2). *Prerequisite:* Registration in Physics 71a.
- 72b. LIGHT LABORATORY (CONTINUED).—Spectroscopy and photographic photometry. II, (2). *Prerequisite:* Registration in Physics 71b.
73. ELEMENTARY PHOTOGRAPHY.—Photographic equipment and materials; emulsion speeds, exposure, development, dark-room technique, intensification and reduction, light sources and printing processes; color photography, color sensitivity, color filters, infra-red and ultra-violet; cinematography, stereoscopic photography, photomicrography, and aerial photography. II, (3). *Prerequisite:* General physics; consent of instructor.
80. ATOMIC PHYSICS.—A lecture course dealing with cathode rays, photoelectricity, x-rays, radioactivity, atomic structure, etc. I, (3). *Prerequisite:* General physics and calculus.
81. RADIOACTIVITY AND NUCLEAR PHYSICS.—II, (3). *Prerequisite:* Physics 80.
- 97-98. THESIS.—I and II, (3). *Prerequisite:* Senior standing and approval of head of department.

Courses for Graduates

NOTE:—A year of calculus and a year of general physics, with laboratory, are prerequisite for all major and minor graduate work in physics. In addition, graduate students whose major is physics must have had one more advanced course in either physics or mathematics and should be able to use references in German.

109. HISTORICAL DEVELOPMENT OF PHYSICS.—II, (1 unit).
122. DYNAMICS.—Continuous through I and II, (1 unit). Dr. DANCOFF.
123. DYNAMICAL THEORY OF SOUND.—II, (1 unit). Dr. BOLT.
125. HYDRODYNAMICS.—Especially modern problems in flow and turbulence. I, (1 unit).
- 127a-127b. RELATIVITY.—Continuous through I and II, ($\frac{1}{2}$ unit). Associate Professor MOTT-SMITH.
128. PROBLEMS AND METHODS IN THEORETICAL PHYSICS.—I, (1 unit).
- 129a-129b. MECHANICAL VIBRATION.—Continuous through I and II, ($\frac{1}{2}$ unit).
- 144a-144b. ADVANCED ELECTRIC AND MAGNETIC MEASUREMENTS.—Continuous through I and II, (1 unit).
- 146a-146b. ELECTRODYNAMICS.—Continuous through I and II, (1 unit). Assistant Professor SERBER.
160. THERMODYNAMICS.—I, (1 unit).
163. STATISTICAL MECHANICS.—II, (1 unit). Associate Professor MOTT-SMITH.
- 170a-170b. ADVANCED PHYSICAL OPTICS.—Electromagnetic theory of light. Continuous through I and II, (1 unit). Associate Professor ALMY.
- 181a-181b. QUANTUM MECHANICS.—I and II, (1 unit). Assistant Professor SERBER.
182. CONDUCTION OF ELECTRICITY THROUGH GASES.—I, (1 unit). Associate Professor MOTT-SMITH.
- 183a-183b. NUCLEAR PHYSICS.—Continuous through I and II, (1 unit). Assistant Professor GOLDBER.
184. LINE SPECTRA AND ATOMIC STRUCTURE.—I, (1 unit). Associate Professor ALMY.
185. BAND SPECTRA AND MOLECULAR STRUCTURE.—II, (1 unit). Associate Professor ALMY.
- 186a-186b. ADVANCED QUANTUM MECHANICS.—Continuous through I and II, (1 unit).
190. RESEARCH.—I and II, (1 to 3 units). Professors in the department.
- 191a-191b. MODERN LABORATORY PRACTICE.—Continuous through I and II, (1 unit). Assistant Professor HAWORTH.
198. SEMINAR.—I and II, (1 to 2 units). Assistant Professor GOLDBER.
199. PHYSICS COLLOQUIUM.—Weekly meetings of instructors and advanced students for the presentation and discussion of papers on current problems. Attendance expected of all graduate students. I and II, (no credit). Associate Professor MOTT-SMITH.

THEORETICAL AND APPLIED MECHANICS

Professors: SEELY (Head of the Department), TALBOT (Emeritus),
MOORE, ENGER, RICHART, PUTNAM, DRAFFIN.

Associate Professors: ENSIGN, SCHRADER.

Assistant Professors: FLEMING, SCHWALBE, JENSEN, KITTREDGE, DOLAN,
LANSFORD, COLLINS.

Associates: BROWN, SUPPGER.

Instructors: JONES, SMITH, BLACK, EHASZ, FINDLEY.

Cooperating: Assistant Professors N. M. NEWMARK and ALBERT JORGENSEN, Mr. M. J. GOGLIA.

Courses for Undergraduates

1. ANALYTICAL MECHANICS (STATICS).—Force systems; equilibrium; centroids; center of gravity; friction. I and II, (2). *Prerequisite:* Mathematics 7; registration in Mathematics 9.
2. ANALYTICAL MECHANICS (DYNAMICS).—Kinematics and kinetics. I and II, (3). *Prerequisite:* Theoretical and Applied Mechanics 1.
3. RESISTANCE OF MATERIALS.—Mechanics of materials; properties and requirements for materials of construction. I and II, (3). *Prerequisite:* Theoretical and Applied Mechanics 1.
4. HYDRAULICS.—Pressure and flow of water, utilization as motive power. I and II, (2). *Prerequisite:* Theoretical and Applied Mechanics 1; registration in Theoretical and Applied Mechanics 2.
- 17-18. ELEMENTS OF MECHANICS (STATICS) AND STRENGTH OF MATERIALS.—Force systems; equilibrium; friction, centroids; direct stress, riveted joints, beams, moment of inertia, deflection, columns. For architects and others who have not taken the calculus. Continuous through I and II, (3). *Prerequisite:* Mathematics 6a.
63. RESISTANCE OF MATERIALS LABORATORY.—Tests to determine properties and to illustrate mechanics of materials. I and II, (1). *Prerequisite:* Registration in Theoretical and Applied Mechanics 3.
64. HYDRAULICS LABORATORY.—Measurements of flow, friction in pipes, pumping and power. I and II, (1). *Prerequisite:* Registration in Theoretical and Applied Mechanics 4.
- 97-98. THESIS.—I and II, (1 to 3). *Prerequisite:* Senior standing and approval of head of department.

Courses for Advanced Undergraduates and Graduates

41. ADVANCED MECHANICS OF MATERIALS.—Special problems met in engineering. I, (3). *Prerequisite:* Theoretical and Applied Mechanics 3 and 63.
42. PROPERTIES OF ENGINEERING MATERIALS: SPECIFICATIONS.—Properties and uses of materials of construction. II, (3). *Prerequisite:* Theoretical and Applied Mechanics 3 and 63.
43. FLUID MECHANICS AND ADVANCED HYDRAULICS.—Classroom discussion of theory and experimental work in laboratory. I and II, (3) (or $\frac{1}{2}$ to 1 unit). *Prerequisite:* Theoretical and Applied Mechanics 4 and 64.
44. ADVANCED LABORATORY WORK IN TESTING MATERIALS.—Testing machines and strain measuring apparatus; practice in making standard and special tests in tension, compression, torsion, and flexure. I and II, (3) (or $\frac{1}{2}$ to 1 unit). *Prerequisite:* Theoretical and Applied Mechanics 3 and 63.
47. ENGINEERING ANALYSIS.—Methods of analysis in engineering mechanics, including the mathematical, model analogy, graphical, dimensional, statistical, and various approximate methods. I, (3) (or $\frac{1}{2}$ to 1 unit). *Prerequisite:* Theoretical and Applied Mechanics 2 and 3.
48. ENGINEERING ANALYSIS.—Continuation of 47. II, (3) (or $\frac{1}{2}$ to 1 unit).
49. ADVANCED DYNAMICS AND VIBRATIONS.—Free, forced, and damped vibrations of structures and machines, resonances, self-induced vibrations. I, (3) (or $\frac{1}{2}$ to 1 unit). *Prerequisite:* Theoretical and Applied Mechanics 2 and 3.
50. ADVANCED DYNAMICS AND VIBRATIONS.—Continuation of 49. II, (3) (or $\frac{1}{2}$ to 1 unit).

Courses for Graduates

NOTE:—Graduate students electing theoretical and applied mechanics as their major must have had the equivalent of the undergraduate courses required for a bachelor's degree in general engineering. The courses open to seniors (listed above) may be taken for minor credit by graduate students whose major is in other departments.

101. DEVELOPMENT OF BASIC IDEAS IN MECHANICS.—I and II, (1 unit). Professor MOORE.
103. FLUID MECHANICS.—I and II, (1 unit). Assistant Professor KITTREDGE.
107. LABORATORY INVESTIGATIONS IN STRENGTH OF MATERIALS.—I and II, (1 to 2 units). Professor MOORE, Assistant Professor DOLAN.
108. LABORATORY INVESTIGATIONS IN HYDRAULICS.—I and II, (1 to 2 units). Assistant Professors KITTREDGE and LANSFORD.
109. LABORATORY INVESTIGATIONS IN PLAIN AND REINFORCED CONCRETE.—I and II, (1 to 2 units). Professor RICHART.
110. ANALYTICAL STUDY OF EXPERIMENTAL WORK ON REINFORCED CONCRETE.—Beams, frames, and footings. I, (1 unit). Professor RICHART.
111. ANALYTICAL STUDY OF EXPERIMENTAL WORK ON REINFORCED CONCRETE.—Columns and slabs. II, (1 unit). Professor RICHART.
112. STRUCTURAL MECHANICS.—Survey of methods of determining deformations and stresses in built-up structures, especially statically indeterminate structures. I, (1 unit). Assistant Professor SCHWALBE.
113. SELECTED TOPICS IN STRUCTURAL MECHANICS.—II, ($\frac{1}{2}$ unit). Assistant Professor SCHWALBE.
114. THEORY OF ELASTICITY WITH APPLICATIONS TO ENGINEERING PROBLEMS.—I, (1 unit). Assistant Professor NEWMARK.
115. THEORY OF ELASTICITY WITH APPLICATIONS TO ENGINEERING PROBLEMS.—Continuation of 114. II, (1 unit). Assistant Professor NEWMARK.
116. RESISTANCE OF MATERIALS.—I, ($\frac{1}{2}$ to 1 unit). Professor SEELY.
117. PROPERTIES OF ENGINEERING MATERIALS.—II, ($\frac{1}{2}$ to 1 unit). Professor SEELY.
198. THESIS.—I and II, (1 to 2 units). Members of the department.

Graduate Work and Research

AS ENGINEERING science and practice develop and expand in multitudinous ways, it becomes increasingly evident that the standard four-year curricula do not provide time for more than a thorough education in the underlying physical and mathematical sciences and a moderate amount of application of these sciences to problems of design, construction, and operation, together with a substantial groundwork in language, social sciences, and some of the arts. There is little opportunity in the four-year program for really advanced work in engineering science. Therefore, the College of Engineering encourages graduates of high scholastic interest and achievement to continue their training into the graduate field for at least one year, or until they have earned the master's degree, in the belief that graduate work pays liberally by every standard of appraisal.

Each department of the college, except General Engineering Drawing, is provided with adequate facilities and a competent staff to conduct graduate work in almost all phases of its field of engineering interest. The staff members who supervise graduate work are also considered as members of the Graduate School Faculty. Students register in the Graduate School, and on its certification degrees are conferred.

Admission to full graduate status in engineering presupposes the completion of a four-year curriculum of study in the field in which the student proposes to do graduate work, either at the University of Illinois or at some other accredited institution in a substantially equivalent curriculum. Students who do not meet these requirements in full, and who are not candidates for a master's degree, may be admitted to graduate study in courses for which they have special preparation. Full particulars concerning graduate work and advanced degrees, including professional degrees in engineering, are given in the *Graduate School Announcement*, which may be obtained by addressing the Dean of the Graduate School, 109 Administration Building, Urbana, Illinois.

Graduate work in engineering is very often associated with the research programs of the Engineering Experiment Station, both in connection with the investigations sponsored by cooperating agencies in industry and with investigations maintained solely by the College of Engineering itself. This relationship furnishes a most valuable opportunity for the exercise of individual and creative initiative in addition to bringing the young investigator into direct and close personal contact with a corps of research men of wide experience.

The facilities for large-scale, wide-range investigations are exceptional. Typical of the equipment for such purposes are the 3,000,000-pound Emery-Tatnall testing machine, the warm air heating research residence, the steam and water research home, the steam and electric railway test cars, the high-pressure gas building, and the laboratories for handling and testing large specimens. Research is also conducted at various places in the country on industrial equipment and structures under actual operating conditions. This kind of research is typified in the test work on railway track.

The results of investigations carried on in the ways outlined are pub-



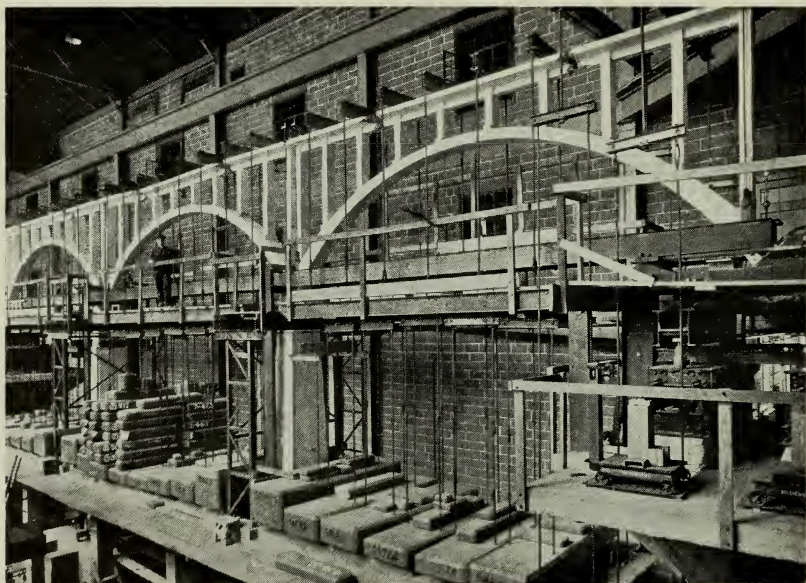
MEASURING STRESSES IN RAILS WITH STREMMATOGRAPHS ON THE RICHMOND,
FREDERICKSBURG, AND POTOMAC R.R. IN VIRGINIA



MEASURING STRESSES IN RAIL AND JOINT BARS WITH MAGNETIC STRAIN
GAGES ON THE PENNSYLVANIA RAILROAD IN MARYLAND



EXPERIMENTAL WARM AIR HEATING RESIDENCE



A THREE-SPAN TEST ARCH IN THE STRUCTURAL RESEARCH LABORATORY

lished in the form of theses, articles in the technical press, and in bulletins of the Engineering Experiment Station, thus making the results widely available to industry and the public generally.

The University normally maintains fourteen research graduate assistantships in the Station. In addition, several other assistantships are usually maintained by industrial organizations, the number varying from year to year. These assistantships are open to graduates of approved universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. These assistantships carry a nominal stipend and freedom from tuition, incidental, and laboratory fees in courses that count for graduate credit. Appointment must be accepted for two consecutive collegiate years, at the expiration of which, if all requirements have been met, the degree of Master of Science is conferred. Not more than half of the time of these assistants during ten months of each year is required in connection with the work of the department to which they are assigned; the remainder of their time is available for graduate study. Further details concerning the research graduate assistantships may be obtained by addressing the Director of the Engineering Experiment Station, 106 Engineering Hall.

The Station has published 322 bulletins, 40 circulars, and 15 reprints. All these publications are regarded as contributions to the literature of engineering, and many of them present important additions to the science of engineering.

General Information for Students

THE EDUCATIONAL and social progress and development of students in the College of Engineering are promoted in many ways. On the campus of a large university in which are enrolled both graduate and undergraduate students of wide educational and professional interests, the opportunities for self-development of the engineering student outside the classroom and laboratory are greatly enhanced. Though it is impossible in this publication to describe all the matters of interest to a prospective student, some of the more important phases of college life at the University of Illinois are presented in the following paragraphs.

Living Accommodations

Students attending the University of Illinois live in private rooming places, University residence halls, and fraternity and sorority houses. The University operates two large residence halls and several smaller ones for women, and one dormitory for men. Most of the students rooming in private homes eat at restaurants and lunch rooms or at "boarding clubs." A boarding club is a private house where groups of students, regardless of where they room, come together for their meals. The 60 fraternities and 24 sororities serve meals to their members.

Students who do not join sororities or fraternities are usually classed as "Independents." In order that this group may have a voice in matters pertaining to student problems, the non-sorority group has an organization known as the Woman's Group System, and the non-fraternity group has its Independent Council.

Suggestions to students concerning places with suitable living and study conditions may be obtained from the offices of the Director of Student Housing, the Dean of Men, and the Dean of Women. The Housing Division enforces the necessary regulations to maintain proper standards of health, safety, comfort, moral surroundings, social facilities, study conditions, and reasonableness of charges in student homes.

Prices vary widely, according to quality and location. The average range is from \$10 to \$15 a month for rooms with the better-class accommodations, and from \$25 to \$35 a month for meals. Most students live close to the campus and therefore do not spend much money for transportation.

Annual Expenses

The annual expenses of students vary, of course, with individual tastes and standards of living. They are somewhat greater in the engineering curricula than in some of the other curricula of the University, because of the larger amount of laboratory work involved and the need for drawing equipment, slide rule, handbooks, and other supplies. The laboratory fees and costs of supplies also vary according to the curriculum chosen in engineering. The minimum annual budget for an engineering student is estimated to be about \$540, divided as shown in the table on page 83.

Fees.—The fees for each semester are due and payable at the time of registration. The amount of fees is not the same for all semesters, nor for

Estimated Minimum Annual Expense Budget

Board.....	\$225
Room.....	80
Clothing.....	50
Incidental fee (Illinois residents).....	70
Laboratory fees (excluding ceramics at \$31).....	15
Gymnasium locker.....	2
Illini Union service charge.....	5
Hospital Association (optional but advised).....	6
Textbooks.....	25
Supplies (\$30 additional for the first year).....	10
Railroad fare.....	20
Laundry (mailed home).....	10
Miscellaneous.....	25
	\$542

all students. Freshmen, for example, must pay certain fees not required of upperclassmen, and not included in the above table of minimum expense.

Each student entering the University as a candidate for a degree pays a *matriculation* fee of \$10; and when he has completed the requirements for the degree, he pays a *graduation* fee of \$10. If, after graduation, the student continues his work as a candidate for another degree, he does not pay the matriculation fee again, but the graduation fee is assessed for each degree conferred.

The *incidental* (tuition) fee is \$35 a semester, making \$70 a year, for students who are residents of the State of Illinois. It is higher for students who are not residents of Illinois, being \$62.50 a semester, or \$125 a year. (Out-of-state students should also allow for other modifications in the accompanying table of expenses, according to the distance of their homes from Urbana.) The eligibility of a student to register as a resident of the State of Illinois is determined by the Registrar of the University.

The *laboratory* fees cover the cost of materials provided by the University for use by students and the cost of such special services as are chargeable to a particular course. These fees amount to approximately \$20 in the freshman year of all engineering students. In the other years they vary with the curriculum, depending on the amount of laboratory work in which the student is engaged. The highest assessment of such fees is \$43 for the sophomore year in the ceramics curriculum; the lowest is \$6.50 for the senior year in civil engineering.

An *unclassified student*, that is, one who is not a candidate for a degree, pays each semester a fee of \$7.50 in addition to the regular incidental fee stated above.

A deposit of \$5 is made by each student to cover charges for such items as library fines, lost books, shortages in laboratory equipment, et cetera. An additional deposit of \$10 is made by all students withdrawing military equipment. Balances are refunded when equipment is returned.

Student Health

Health Service.—All matters affecting the general health conditions of the students are in the care of the University Health Service. The staff of the Health Service Station is made up of men and women well-trained in medicine and public health. Members of the staff conduct the physical

examinations required of all students entering the University, teach the courses in hygiene, hold conferences with students on individual health problems, and have charge of campus sanitation. They give emergency and first-aid treatment in cases of accidents in and about University buildings. Students with physical defects which are likely to become serious are required to report periodically to the Health Service Station for re-examination. Diagnostic advice of the staff is available at any time during the year to all students without charge, and this consulting service is a means for the control of contagion and for the prompt discovery of cases in which students need to be referred to their family physicians for treatment.

Hospital Association.—The Mutual Benefit Hospital Association provides hospital care at a minimum cost to the student. Semester dues are three dollars, and members of the association are entitled to ward care in the University's hospital for a period not to exceed twenty-eight days. The benefits of membership cover room and board while the student is hospitalized, but not laboratory charges and physicians' fees. There is also available a five-dollar membership which covers certain payments to physicians.

The McKinley Memorial Hospital, which is the University's hospital, serves both students and faculty. It is a well-equipped modern plant, located in the Forestry, near the flower gardens on the south campus. Normally it can accommodate 125 patients. All students who are ill in the hospital are assured of good care in pleasant surroundings by physicians of their own selection.

Student Employment

The University maintains a Student Employment Bureau which aids students in finding work while they are on the campus. About one-third of the students in the College of Engineering earn a part of their expenses, but none should plan to do so unless it is absolutely necessary. There are always more needy applicants than there are jobs available, and more than half of the students employed earn only room, or board. A new student should keep in mind that most places are filled at the close of each year by those already in the University, and that he cannot expect certainly to obtain work as soon as he arrives on the campus. He should have a reserve fund of at least \$250 before beginning his first year of college, for with a smaller amount his financial condition would be so precarious as to endanger his health and his success in school. If self-support is contemplated beyond earning board, or room, the student should plan to extend his engineering curriculum over five years instead of four. Communications concerning employment may be addressed to the Director of the Student Employment Bureau, 104 Administration Building, Urbana, Illinois.

Scholarships and Loan Funds

A number of undergraduate scholarships have been provided for worthy students who are in need of financial aid. The scholarships available to new students exempt their holders from the payment of the matriculation fee (\$10) and the incidental fee (\$35 each semester), but not laboratory fees. Engineering students are eligible to receive the following scholarships under regulations fixed by the University and administered by the Registrar: County Scholarships, awarded through competitive examinations, one for

each county in Illinois; General Assembly Scholarships, awarded on nomination by members of the State Legislature; and a number of others. Further information concerning scholarships will be furnished by the Registrar of the University.

The University has several funds from which loans may be made to worthy needy students. Except for small short-term loans to meet emergencies, these funds are used to finance students of good scholastic achievement who have been in the University long enough to indicate with a fair degree of certainty that they will finish the work required for graduation. The loans are repaid after graduation at reasonable rates of interest. Freshmen are not ordinarily eligible for loans.

Prizes and Awards

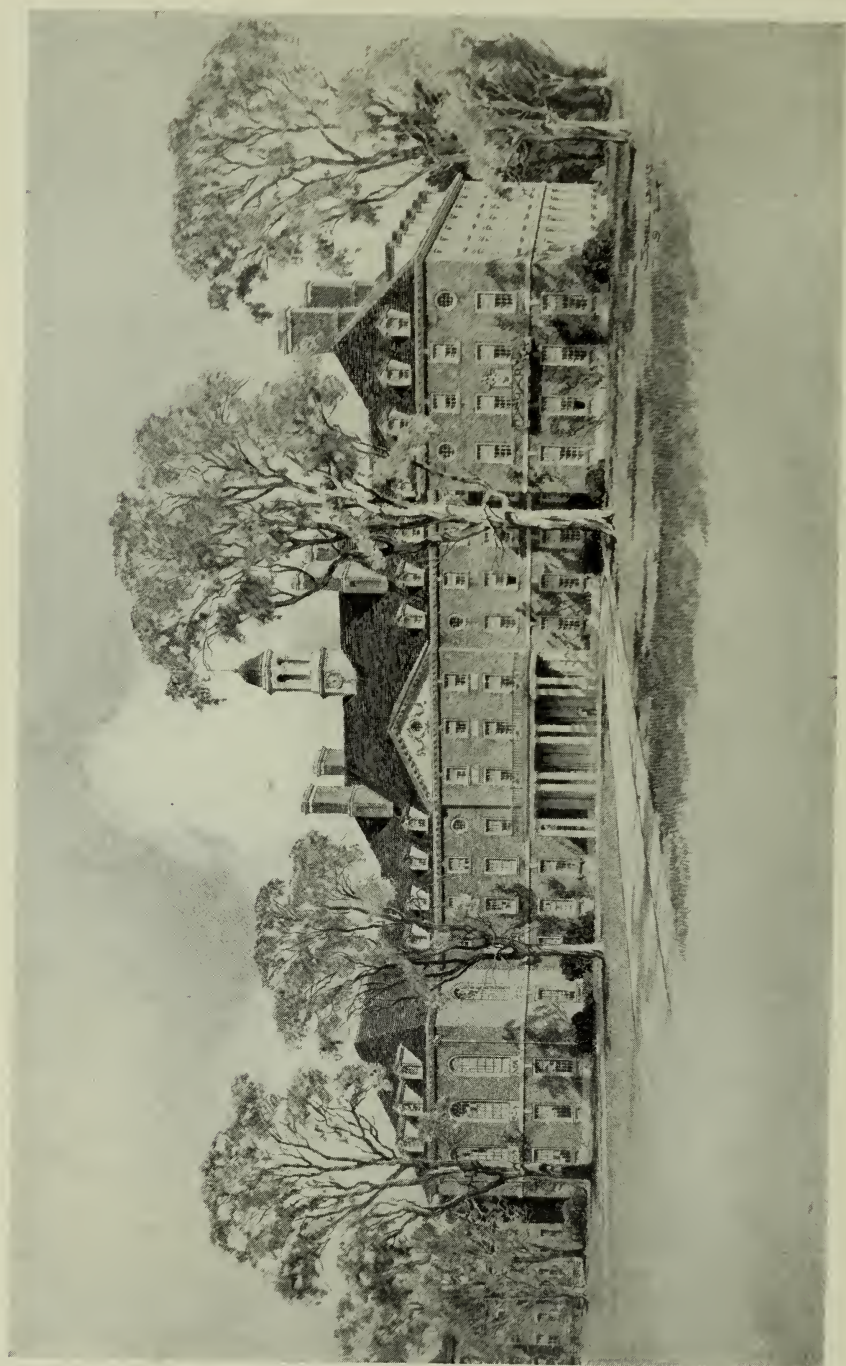
Engineering students are eligible to compete for many University prizes of varying amounts and character. In addition, numerous prizes and awards restricted to engineering students have been made available through the generosity of individuals and of engineering organizations. Information concerning them may be obtained from the Dean of the College of Engineering.

Honors and Honorary Societies

Students in engineering are graduated with honors or high honors on the basis of exceptional scholastic achievement in certain specified courses, totaling about forty semester hours, in the junior and senior years of each curriculum, and superior accomplishment in all other work of the curriculum. University recognition of high scholastic standing is also given in the Honors Day Convocation in which engineering students of all classes are included in numbers proportional to their registration in the University. College recognition of the achievements of engineering students is given in several ways, chiefly through the honorary organizations of *Tau Beta Pi* and *Sigma Tau*. There is also, in each department, an organization with national affiliations that marks the outstanding students of the group in a fitting manner. Prominent among these are *Keramos* in Ceramics and Ceramic Engineering, *Chi Epsilon* and *Mu San* in Civil Engineering, *Eta Kappa Nu* in Electrical Engineering, and *Pi Tau Sigma* in Mechanical Engineering. Prizes and awards are made to outstanding students by many of these organizations. In addition, engineering students are eligible to election to honor societies of an all-university character.

Student Organizations and Activities

In the belief that extra-curricular activities are potent factors in the development of the well-trained engineer, the College of Engineering fosters numerous organizations and enterprises which furnish opportunity to the students to employ their time and energies in desirable ways outside the strictly academic requirements of their curricula. Among the three hundred or more associations, societies, and clubs on the University campus, offering opportunity for the development and expression of varied interests and talents, there are seven student organizations of a professional character in the College of Engineering, one in each degree-granting department, which are affiliated with national societies as branches or chapters of the parent



THE ILLINI UNION BUILDING, CENTER OF STUDENT ACTIVITIES

organization. These societies are managed entirely by the students and furnish an effective means for promoting the professional development of the young engineer. Prominent practicing engineers appear on the programs of these societies at regular intervals. Activities that are all-college in character are sponsored by the societies, acting through a council made up of officers of these organizations. Unique among the student activities are the Electrical Show and the Engineering Open House which are given in alternate years by the students. The success of these enterprises is indicated by the considerable size of the student loan fund built up from the proceeds of the Electrical Show during the twenty or more years of its existence.

Engineering students are encouraged to participate in student activities, thus developing a side of their personal training that cannot be accomplished so readily in the class room and laboratory. Few of the many activities on the campus lack engineering students on their boards of direction or in their working personnel.

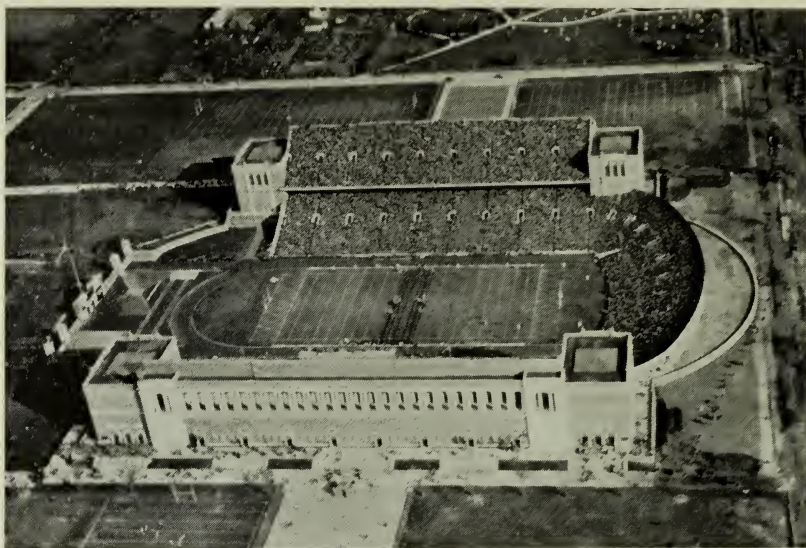
The new Illini Union Building is the center of student activities on the campus. This building provides space for the meetings of student organizations, the offices of the Alumni Association, a bookstore, a cafeteria, a ball-room, game rooms, bowling alleys, a browsing room, a music room, faculty and student lounges, and general offices for ticket sales to University events.

Physical Education and Athletics

An extensive and well-rounded program of physical development for both men and women is carried on by the University. The equipment and playgrounds are modern and adequate. Formal courses in calisthenics, sports, and hygiene are compulsory for the first two years and elective thereafter. Outside of the requirement that all students must learn to swim, the selection of courses is left to the student. Supplementing the formal curricular requirements in physical education is a program of voluntary intramural sports, competitions, and exhibitions, sponsored by the School of Physical Education. These activities are widely participated in by students of all classes. Intercollegiate athletics form a fitting climax to the University's program of physical education and sports activities. Even though comparatively small numbers of students are able to engage in intercollegiate competition, these sports are held in high esteem by the student body generally, and they undoubtedly inculcate a lively spirit of honest effort and fair play in the hearts of thousands of young men and women who witness the games each year.

Military Training

All male students who are citizens of the United States and physically fit, except students over twenty-two years of age when entering the University and students entering the University with junior standing, must register in Military Science and Tactics, and unless properly excused, must take the full basic course therein, whether they intend to graduate or not. The University Brigade consists of six units of the Reserve Officers' Training Corps: Infantry, Field Artillery, Cavalry, Engineers, Signal Corps, and Coast Artillery. A student is normally free to choose any branch for which his aptitude and course of study fit him. However, the Signal Corps is reserved



THE MEMORIAL STADIUM

for electrical engineers specifically, and the Engineer Corps is elected by all other engineers with few exceptions. The basic course of two years of work is a general prerequisite for graduation. The final two years of work, which are optional, are called the advanced course, and students in the advanced course serve as the officers of the brigade; completion of the advanced course qualifies the candidate for a commission in the organized reserves of the United States Army.

Who Should Study Engineering

WHEN the high school senior is faced with the problem of choosing a life vocation, he finds it difficult to make a decision. Since most boys of high school age have had little or no industrial or commercial experience, they lack the information they need to form a correct judgment of the requirements, both personal and educational, of the numerous vocations. This is particularly true of those vocations which have become professional or semi-professional in character. The common opinion is that people are *born* to be engineers, doctors, lawyers, and other professional persons. This is true only in a most general sense. One may have good natural abilities and may develop desirable personal characteristics, but he must supplement these traits by long periods of training and hard work to become successful in any professional calling. It is undoubtedly true that any capable boy can learn the theoretical basis of almost any profession and still not be able to acquire the manual and mental skills and techniques of the particular profession he has chosen. What is of even more importance, he may not be able to acquire the career-enthusiasm so essential to success in the practice of the profession. His ability in these respects depends largely on his personal traits, which have been determined to a considerable extent by early training and environment.

The young man should, therefore, take account of the requirements of the profession he is thinking of entering and also make an inventory of his own personal traits and characteristics, to determine, if possible, whether he will be effective and happy in the profession he selects. He must first secure all the information he can about the profession—its physical and intellectual requirements, its exactions, limitations, and rewards. He should make a careful appraisal of his own mental, emotional, and physical endowments on some kind of a personal rating scale, several of which are now available in convenient form. He should next seek the advice of men actively at work in the profession and then the counsel of teachers, parents, and friends. Finally, the balance sheet, as it were, must be struck and a decision made. This decision should not be considered irrevocable. New stimuli and even the forces of chance may serve to change the conclusions first formed. An incidental advantage of such critical self-analysis and vocational appraisal is that they set the individual out from the crowd, stamp him as one with purpose and foresight, and bring to his aid the helpful and sympathetic interest of those competent to give sound vocational advice. However, the final choice must rest wholly with the individual. The courage to accept his own analysis with conviction and trust, coupled with the determination to test the correctness of his conclusions with every ounce of energy and mental acumen he possesses, will quickly bring any young man to a place of vantage from which he may reappraise the items in the balance sheet with exactness and certainty.

Scientific and technical advancements play an important part in every phase of modern life. No one can hope to succeed even moderately in the profession of engineering, where these advancements play the chief part, without first learning what scientific principles there are and how they are

applied by the engineer in our complex civilization. Choosing an engineering career, therefore, is in reality determining to study engineering in a standard college or institute. No other satisfactory approach to successful practice in the profession is available. The process of slowly rising through the ranks without such an education is laborious and disheartening, to say the least.

It is the purpose of the following paragraphs to present a few outstanding characteristics of the profession of engineering and a few of the personal qualities demanded of its practitioners.

Since the minimum educational requirement for admission to truly professional engineering work is graduation from an engineering or technical institution, the first important fact to be kept in mind is that a well-balanced but in some respects special preparation in the high school is prerequisite to admission to these institutions (see "Admission Requirements" in an earlier section). Any college of engineering in the student's region will be glad to supplement the information from teachers and friends on this point. The few special requirements, particularly in mathematics, should be checked up at the beginning of the senior year in high school. At least three units of mathematics, including solid geometry, are required by all standard schools of engineering.

The second fact of importance to be weighed carefully is that engineers must be analytical-minded. By this is meant more than just mathematical expertness, although one should like mathematics and learn it readily if he is to make the greatest success in engineering. The mental characteristic referred to as analytical-mindedness is rather the desire to seek out and determine facts, to arrange facts and events in their logical sequences, and to deduce from them correct and useful conclusions. Everyday manifestations of this trait of mind are sometimes referred to as good judgment and scientific sense. It is generally accompanied by an inborn curiosity about how things operate and are put together. This characteristic is a prime essential in engineering practice and should be given great weight in considering one's qualifications for an engineering career.

In the third place, engineering deals with the applications of the physical sciences to the industrial and community life of the time. It functions through design, manufacture, construction, maintenance, and operation. Technical achievement must be based on a knowledge of chemistry, physics, mechanics, and mathematics, supplemented by skills in the graphic and manual arts. Esthetic considerations are also of great importance in engineering work, particularly in design and construction. The engineer's structures must be beautiful as well as functional if he wishes to hold the place of prestige in public esteem that the magnitude of his works entitles him to hold. One planning his life work in any branch of engineering should feel a strong interest in and a stimulation from his preparatory work in the sciences and arts. These interests should be given a prominent place on the asset side of the personal rating chart.

Engineering is a profession of action. Its practitioners must have both energy and perseverance and must be ready at all times to assume responsibility in whatever direction demanded. Intellectual vigor and honesty are also prime essentials. Sound decisions, based on careful analyses and followed by rapid and skillful execution, are requisites to progress in engineer-

ing work. No one should contemplate an engineering career who is unwilling to submit to the mental rigors and disciplines that these requirements impose.

Again, those who practice the profession of engineering are constantly brought into direct and intimate contact with problems of a social, or human, character. This has always been true to a greater or less degree, but in the present-day complex life of the nation it is imperative that those in charge of private and public enterprises rely to the fullest extent upon the knowledge, judgment, and experience of the engineer, both in determining what should be done and how to do it. The engineer, in turn, must know the needs and desires of society. He must employ many men in carrying out designs and plans that have been made and, therefore, he must know how to handle men and their community problems. He must appear before boards and commissions and discuss intelligently and convincingly the economic and social effects of proposed engineering work. No longer is it possible for him to confine his sphere of activities to "the use of the materials and forces of nature for the benefit of mankind." Human forces must be included in his planning.

Because of these changed conditions, trained engineers are being sought out more and more and placed in positions of trust and responsibility quite outside those of a strictly technical nature, where economic, educational, and social questions are the predominating ones. All this suggests the fact that a young man who contemplates entering the engineering profession should possess and be anxious to develop those qualities of mind and personality that will make him effective in these broad spheres of activity as well as in the technical phases of his work.

It goes without saying that the truly professional engineer must be a technically trained man in the real sense of the word. His primary field of activity embraces all the materials and forces of nature. To make them serve the manifold needs and pleasures of mankind is his job. This means intense technical training and a long period of engineering apprenticeship to gain practical experience. In spite of these facts, engineering is not a closed profession as are the medical and legal professions. There are many grades of responsibility through which an engineer must pass in reaching the position of chief engineer, any one of which may be considered an end in itself. There are also many well-defined sub-professional classifications for those who prefer the narrower fields of activity, such as surveyors, draftsmen, foremen, superintendents, technicians, and others. Sub-professional experience is also a stage or stepping-stone for those seeking the highest professional status. An engineering education is a profitable investment even if considered only as a preparation for sub-professional work.

Finally, the young man beginning the study of engineering should understand the differences between the profession of engineering and the various crafts and trades allied and supplementary to it. He should not mistake the work of the machinist, the electrician, and the skilled artisan in other crafts for the scientific and professional work in engineering. One interested only in a career of craftsmanship should not ordinarily plan to study in an engineering college. He will find the various mechanics institutes much more suitable to his needs at much less cost. This is not to say that engineering is something quite apart from the skilled trades and crafts. Every engineer

should be an artisan in his own right, but the training required in each classification is greatly different.

Financial rewards in engineering practice vary as a matter of course with the different degrees of professional status attained. Against the cost of an engineering education one may set a scale of remuneration beginning on the average at \$125 to \$150 a month at graduation and increasing steadily to the higher brackets of \$7,000 to \$15,000 a year for those who are successful in practice and are put in charge of large engineering organizations and enterprises.

The question—"Who should study engineering?"—cannot be answered by any simple formula or phrase. The range of engineering activities is so great that many men of widely differing abilities and training find opportunity for useful and satisfying work within the boundaries of professional practice. A still greater number of persons are employed in vocations closely connected to professional engineering and absolutely necessary to its existence. For all of these callings an engineering education is fast becoming an indispensable requirement. Consequently, schools of engineering all over the country offer various programs of study, called curricula, which combine the basic scientific and mathematical principles underlying the practice of engineering with economic, social, and cultural studies into a closely integrated and coordinated whole. This has proved a highly successful type of education, even as a preparation for many vocations in this industrial age not included within the sphere of engineering activity.

The foregoing paragraphs have indicated some of the guide posts to be read by a young man contemplating an engineering career. Other suggestions should be sought from published writings of competent men. There is a dearth of literature specifically about engineers and the profession of engineering. On the other hand, there is a great deal written about engineering work and the manner of its accomplishment in more than four hundred technical magazines and journals. Many of these publications can be found in the general city libraries. A young man contemplating a career in engineering should make it a point to read as much as he can in these magazines. The following list contains some of the more valuable and interesting books suitable to the purpose of vocational guidance. It is hoped that most of them are available in every high school library.

The Profession of Engineering, by D. C. Jackson & W. P. Jones, 1929. John Wiley & Sons, New York.

Engineering as a Vocation, by Ernest McCullough, 1911. David Williams Company, 239 West 39th Street, New York, obtainable through the Scientific Book Corporation, 15 East 26th Street, New York.

The Engineer—His Work and His Education, by R. L. Sackett, 1928. Ginn & Company, Boston, Massachusetts.

Engineering as a Career, by the Engineers' Council for Professional Development, 1939. 29 West 39th Street, New York.

Vocational Guidance in Engineering Lines, by the American Association of Engineers, 1933. The Mack Printing Company, Easton, Pennsylvania.

Building an Engineering Career, by C. C. Williams, 1934. McGraw-Hill Book Company, New York.

- The Young Man and Civil Engineering*, by George F. Swain, 1922. Macmillan Company, 60 Fifth Avenue, New York.
- Eminent Engineers*, by Dwight Goddard, 1906. The Derry-Collard Company, New York, obtainable through Norman W. Henley, 2 West 45th Street, New York.
- How to Study*, by George F. Swain, 1917. McGraw-Hill Book Company, New York.
- How to Study Effectively*, by G. M. Whipple, 1916. Public-School Publishing Company, Bloomington, Illinois.
- Addresses to Engineering Students*, by Waddell & Harrington, 1912. Waddell & Harrington, Kansas City, Missouri.
- Careers* (a series of pamphlets), by the Institute for Research, 537 South Dearborn Street, Chicago. 1936 to date.
- Careers in the Mineral Industries*, by Thomas T. Read, 1939. Published by the American Institute of Mining and Metallurgical Engineers through the Seeley W. Mudd Memorial Fund, 29 West 39th Street, New York.

INDEX

- Admission, 40
 - general requirements, 40
 - physical examinations, 40
 - special requirements, 42
 - to correspondence courses, 43
 - to Graduate School, 43
 - unclassified students, 43
 - units required, 41
- Agricultural engineering:
 - administration, 14
 - curriculum, 45
 - faculty, 9
 - laboratories and equipment, 14
 - scope of instruction, 13
- Athletics, 87
- Board of Trustees, 4
- Buildings, 11, 18
- Campus, map, *inside back cover*.
- Ceramics and ceramic engineering:
 - courses for graduates, 60
 - curricula, 46, 48
 - description of courses, 59
 - laboratories and equipment, 20
 - library, 22
 - museum, 22
 - scope of instruction, 14
 - staff, 59
- Chemical engineering:
 - administration, 14
 - curriculum, 49
 - laboratories and equipment, 14
 - scope of instruction, 14
- Civil engineering:
 - courses for graduates, 63
 - curriculum, 50
 - description of courses, 61
 - laboratories and equipment, 22
 - scope of instruction, 15
 - staff, 61
 - Freshmen, common program, 45
- Correspondence courses, 43
- Curricula, 10, 44
 - agricultural engineering, 13, 45
 - ceramic engineering, 14, 46
 - ceramics, 48
 - chemical engineering, 14, 49
 - civil engineering, 15, 50
 - electrical engineering, 15, 52
 - general engineering, 15, 53
 - mechanical engineering, 16, 54
 - metallurgical engineering, 16, 56
 - mining engineering, 16, 57
 - physics (engineering), 16, 52
 - railway engineering, 17
- Degrees, 44
- Departments, laboratories and equipment, 19
 - ceramic engineering, 20
 - civil engineering, 22
 - electrical engineering, 25
 - general engineering drawing, 27
 - mechanical engineering, 27
 - metallurgical engineering, 29
 - mining engineering, 29
 - physics (engineering), 35
 - railway engineering, 35
 - theoretical and applied mechanics, 35
- Drawing, *See* General engineering drawing.
- Electives, 44
- Electrical engineering:
 - courses for graduates, 66
 - curriculum, 52
 - description of courses, 64
 - laboratories and equipment, 25
 - scope of instruction, 15
 - staff, 64
- Employment, 84
- Engineering, general courses:
 - economics, 67
 - history, 67
 - industrial relations, 67
 - law, 67
 - transportation, 67
- Engineering, who should study, 89
- Engineering Experiment Station, 78
- Engineering physics, curriculum, 52
- Entrance requirements, *See* Admission.
- Equipment, 18
- Expenses, 82
- Faculty, by ranks, 5
- Fees, 83
- General engineering:
 - administration, 13
 - curriculum, 53
 - scope of instruction, 15
- General engineering drawing:
 - description of courses, 68
 - laboratories and equipment, 27
 - scope of instruction, 15
 - staff, 68
- Graduate assistantships, 81
- Graduate work, 78
- Health service, 83
- History of College of Engineering, 10
- Honors and honorary societies, 85
- Hospital association, 84
- Instruction, purposes and scope, 12
- Laboratories, engineering, 18
- Language requirement, 44
- Libraries, engineering, 18
- Living accommodations, 82
- Loan funds, 84
- Map of campus, *inside back cover*.
- Mechanical engineering:
 - courses for graduates, 70
 - curricula, 54
 - description of courses, 68
 - laboratories and equipment, 27
 - scope of instruction, 16
 - staff, 68
- Mechanics, *See* Theoretical and applied mechanics.
- Metallurgical engineering:
 - courses for graduates, 73
 - curriculum, 56
 - description of courses, 72
 - laboratories and equipment, 29
 - scope of instruction, 16
 - staff, 71
- Military training, 87
- Mining engineering:
 - courses for graduates, 72
 - curricula, 57
 - description of courses, 71
 - laboratories and equipment, 29
 - scope of instruction, 16
 - staff, 71
- Officers of administration, 4
- Options, 44
- Physical education, 87
- Physics:
 - courses for graduates, 75
 - description of courses, 74
 - laboratories and equipment, 35
 - scope of instruction, 16
 - staff, 73
- Prizes and awards, 85
- Public service, training for, 13

Purposes of instruction, 12
 agricultural engineering, 13
 ceramic engineering, 14
 chemical engineering, 14
 civil engineering, 15
 electrical engineering, 15
 general engineering, 15
 engineering drawing, 15
 mechanical engineering, 16
 mining and metallurgy, 16
 physics, 16
 railway engineering, 17
 theoretical and applied mechanics, 17

Railway engineering:
 courses for graduates, 64, 71
 description of courses, 61, 65, 69
 laboratories and equipment, 35
 scope of instruction, 17

Research, 78

Scholarships, 84
Staff, by ranks, 5
Student center, 86
Student organizations, 85

Theoretical and applied mechanics:
 courses for graduates, 77
 description of courses, 76
 laboratories and equipment, 35
 scope of instruction, 17
 staff, 76

Time table, 59

Unclassified students, 43
Units of credit, 41
University buildings, location, enrollment, etc.,
 inside front cover.

THE JOURNAL OF THE

ROYAL SOCIETY OF MEDICINE

Volume 100, Part 1, 1997

CONTENTS

1. The Role of the General Practitioner in the Management of Chronic Disease
2. The Role of the General Practitioner in the Management of Chronic Disease
3. The Role of the General Practitioner in the Management of Chronic Disease
4. The Role of the General Practitioner in the Management of Chronic Disease
5. The Role of the General Practitioner in the Management of Chronic Disease
6. The Role of the General Practitioner in the Management of Chronic Disease
7. The Role of the General Practitioner in the Management of Chronic Disease
8. The Role of the General Practitioner in the Management of Chronic Disease
9. The Role of the General Practitioner in the Management of Chronic Disease
10. The Role of the General Practitioner in the Management of Chronic Disease

11. The Role of the General Practitioner in the Management of Chronic Disease
12. The Role of the General Practitioner in the Management of Chronic Disease
13. The Role of the General Practitioner in the Management of Chronic Disease
14. The Role of the General Practitioner in the Management of Chronic Disease
15. The Role of the General Practitioner in the Management of Chronic Disease
16. The Role of the General Practitioner in the Management of Chronic Disease
17. The Role of the General Practitioner in the Management of Chronic Disease
18. The Role of the General Practitioner in the Management of Chronic Disease
19. The Role of the General Practitioner in the Management of Chronic Disease
20. The Role of the General Practitioner in the Management of Chronic Disease

KEY TO LOCATION OF BUILDINGS

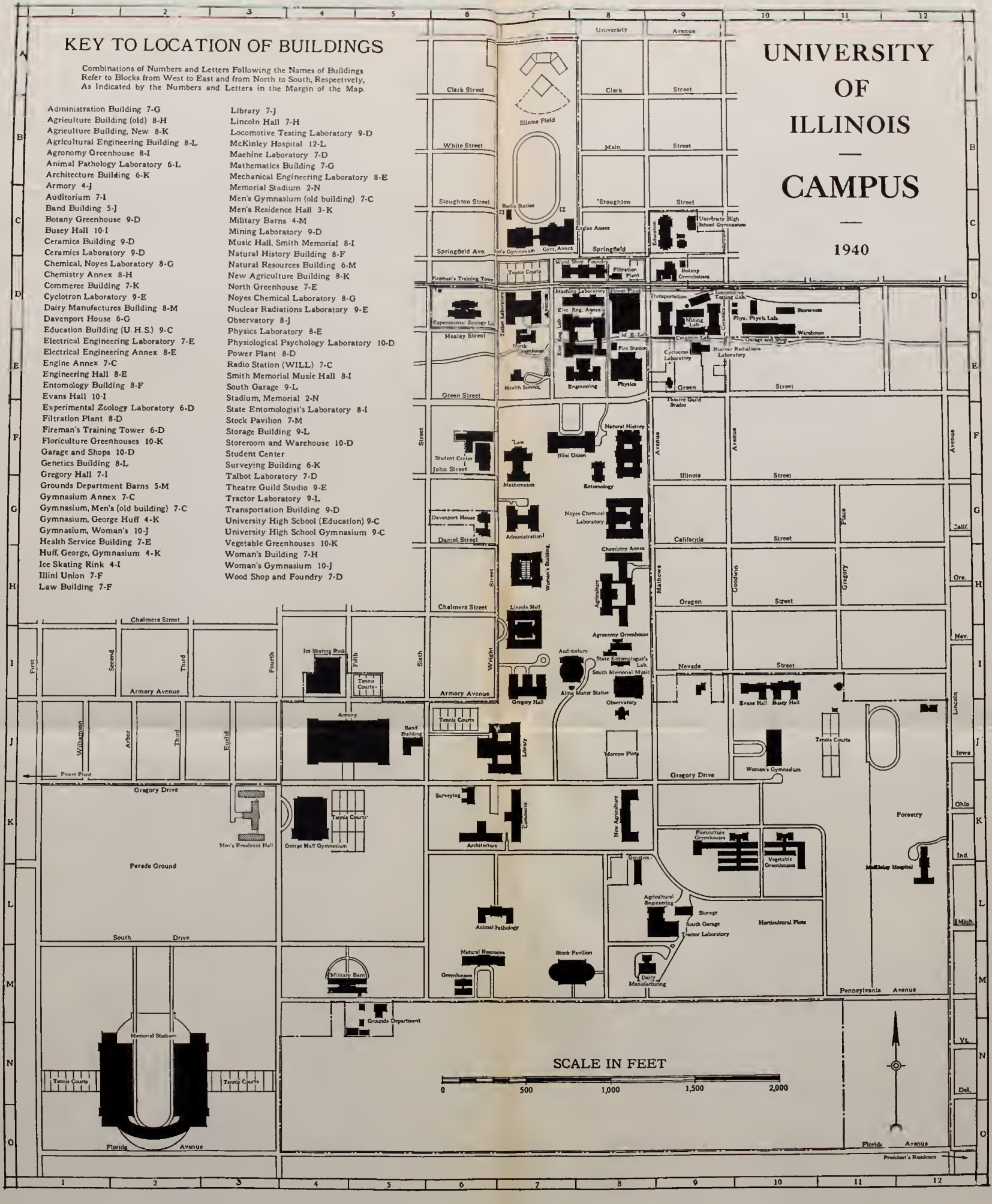
Combinations of Numbers and Letters Following the Names of Buildings Refer to Blocks from West to East and from North to South, Respectively, As Indicated by the Numbers and Letters in the Margin of the Map.

Administration Building 7-G
Agriculture Building (old) 8-H
Agriculture Building, New 8-K
Agricultural Engineering Building 8-L
Agronomy Greenhouse 8-I
Animal Pathology Laboratory 6-L
Architecture Building 6-K
Armory 4-J
Auditorium 7-I
Band Building 5-J
Botany Greenhouse 9-D
Busby Hall 10-I
Ceramics Building 9-D
Ceramics Laboratory 9-D
Chemical, Noyes Laboratory 8-G
Chemistry Annex 8-H
Commerce Building 7-K
Cyclotron Laboratory 9-E
Dairy Manufactures Building 8-M
Davenport House 6-G
Education Building (U.H.S.) 9-C
Electrical Engineering Laboratory 7-E
Electrical Engineering Annex 8-E
Engine Annex 7-C
Engineering Hall 8-E
Entomology Building 8-F
Evans Hall 10-I
Experimental Zoology Laboratory 6-D
Filtration Plant 8-D
Fireman's Training Tower 6-D
Floriculture Greenhouses 10-K
Garage and Shops 10-D
Genetics Building 8-L
Gregory Hall 7-I
Grounds Department Barns 5-M
Gymnasium Annex 7-C
Gymnasium, Men's (old building) 7-C
Gymnasium, George Huff 4-K
Gymnasium, Woman's 10-J
Health Service Building 7-E
Huff, George, Gymnasium 4-K
Ice Skating Rink 4-I
Illini Union 7-F
Law Building 7-F

Library 7-J
Lincoln Hall 7-H
Locomotive Testing Laboratory 9-D
McKinley Hospital 12-L
Machine Laboratory 7-D
Mathematics Building 7-G
Mechanical Engineering Laboratory 8-E
Memorial Stadium 2-N
Men's Gymnasium (old building) 7-C
Men's Residence Hall 3-K
Military Barns 4-M
Mining Laboratory 9-D
Music Hall, Smith Memorial 8-I
Natural History Building 8-F
Natural Resources Building 6-M
New Agriculture Building 8-K
North Greenhouse 7-E
Noyes Chemical Laboratory 8-G
Nuclear Radiations Laboratory 9-E
Observatory 8-J
Physics Laboratory 8-E
Physiological Psychology Laboratory 10-D
Power Plant 8-D
Radio Station (WILL) 7-C
Smith Memorial Music Hall 8-I
South Garage 9-L
Stadium, Memorial 2-N
State Entomologist's Laboratory 8-I
Stock Pavilion 7-M
Storage Building 9-L
Storeroom and Warehouses 10-D
Student Center
Surveying Building 6-K
Talbot Laboratory 7-D
Theatre Guild Studio 9-E
Tractor Laboratory 9-L
Transportation Building 9-D
University High School (Education) 9-C
University High School Gymnasium 9-C
Vegetable Greenhouses 10-K
Woman's Building 7-H
Woman's Gymnasium 10-J
Wood Shop and Foundry 7-D

UNIVERSITY OF ILLINOIS — CAMPUS

1940



UNIVERSITY OF ILLINOIS

Colleges and Schools at Urbana

COLLEGE OF LIBERAL ARTS AND SCIENCES.—General curriculum with majors in the humanities and sciences; a new general curriculum with fields of concentration in mathematics and physical science, biological science, social science, and the humanities; specialized curricula in chemistry and chemical engineering; general courses preparatory to the study of law and journalism; pre-professional training in medicine, dentistry, and pharmacy; curriculum in social administration.

COLLEGE OF COMMERCE AND BUSINESS ADMINISTRATION.—Fields of concentration in accountancy, banking and finance, commerce and law, commercial teaching, economics, industrial administration, management, marketing, and public affairs.

COLLEGE OF ENGINEERING.—Curricula in agricultural engineering, ceramics, ceramic engineering, chemical engineering, civil engineering, electrical engineering, engineering physics, general engineering, mechanical engineering, metallurgical engineering, mining engineering, and railway engineering.

COLLEGE OF AGRICULTURE.—Curricula in agriculture, dairy technology, floriculture, general home economics, and nutrition and dietetics; pre-professional training in forestry.

COLLEGE OF EDUCATION.—Curricula in education, agricultural education, home economics education, and industrial education. The University High School is the practice school of the College of Education.

COLLEGE OF FINE AND APPLIED ARTS.—Curricula in architecture, art, landscape architecture, music, and music education.

COLLEGE OF LAW.—Professional curriculum in law.

SCHOOL OF JOURNALISM.—General and special curricula in journalism.

SCHOOL OF PHYSICAL EDUCATION.—Curricula in physical education for men and for women.

LIBRARY SCHOOL.—Curriculum in library science.

GRADUATE SCHOOL.—Advanced study and research.

Summer Session.—Courses for undergraduate and graduate students.

University Extension Division.—Courses taught by correspondence, extramural courses, science aids service, speech aids service, and visual aids service.

Colleges in Chicago

COLLEGE OF DENTISTRY.—Professional curriculum in dentistry.

COLLEGE OF MEDICINE.—Professional curriculum in medicine.

COLLEGE OF PHARMACY.—Professional curriculum in pharmacy.

University Experiment Stations, and Research and Service Organizations at Urbana

AGRICULTURAL EXPERIMENT STATION	BUREAU OF BUSINESS RESEARCH
ENGINEERING EXPERIMENT STATION	BUREAU OF COMMUNITY PLANNING
EXTENSION SERVICE IN AGRICULTURE	BUREAU OF EDUCATIONAL RESEARCH
AND HOME ECONOMICS	BUREAU OF INSTITUTIONAL RESEARCH
RADIO STATION (WILL)	UNIVERSITY OF ILLINOIS PRESS

State Scientific Surveys and Other Divisions at Urbana

STATE GEOLOGICAL SURVEY	STATE DIAGNOSTIC LABORATORY (for
STATE NATURAL HISTORY SURVEY	Animal Pathology)
STATE WATER SURVEY	U. S. SOYBEAN PRODUCTS LABORATORY

For general catalog of the University, special circulars, and other information, address
THE REGISTRAR, UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

UNIVERSITY OF ILLINOIS-URBANA



3 0112 111989361